



**A FRAMEWORK FOR SUPPORTING TECHNOLOGICAL INNOVATION BY
MANUFACTURING SMALL AND MEDIUM ENTERPRISES IN KZN**

by

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PhD: Business Administration

DECLARATION

I, the undersigned, Miss Luyanda Loraine Bingwa, hereby declare that this dissertation submitted to the Durban University of Technology for the Doctor of Philosophy in Business and Information Management has not been previously submitted to any other institution of higher education. I further acknowledge that the work presented in this study is entirely my own, except where sources are acknowledged.

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DEDICATION

To my dear daughter, Ayanda Luthando Bingwa, you are my greatest source of inspiration. I deeply appreciate your patience and understanding when I had to focus on my research studies. I dedicate this accomplishment to you, my dear child, and I am incredibly proud to be your mother.

ABSTRACT

Unemployment is an ongoing phenomenon in every country. It is rapidly increasing, which leads to a decline in the economy and other societal problems. This is particularly evident in developing countries such as South Africa, where the unemployment rate is 32.9%. The South African government has identified small and medium-sized enterprises (SMEs) as a key aspect of its strategy to reduce unemployment rates and to realise the vision outlined in the National Development Plan 2030. SMEs are major job creators and contribute significantly to the gross domestic product (GDP) of South Africa. They account for the majority of employment opportunities in the country, especially in sectors such as agriculture, manufacturing, and services. SMEs also support economic growth through their capacity for innovation and swift market adaptation. They are ideal for generating innovative ideas due to their pioneering role in adopting new technologies and are particularly adept at identifying gaps in the market which could be addressed through innovative solutions.

There are ongoing debates about the uptake of technology by SMEs in African countries, including South Africa. Some scholars argue that manufacturing SMEs in South Africa have been hesitant to adopt modern technologies, which has hindered their growth and their ability to reach full potential. However, there are counterarguments that provide a more nuanced perspective on the challenges and opportunities for technology adoption among manufacturing SMEs in KwaZulu-Natal (KZN), South Africa. One significant issue is SME owners' inability to fully grasp the complexity of information and communications technology (ICT), which has a negative impact on their decision to adopt ICT. Furthermore, government regulations and compliance requirements have been a crucial factor affecting the viability and growth of manufacturing SMEs. Without a comprehensive understanding of ICT, SMEs find it challenging to make informed decisions about their investments in this field. Critically evaluating the use of Fourth Industrial Revolution (4IR) technologies as a way of improving success rates amongst manufacturing SMEs in KZN will enable the development of a framework which can provide practical guidance for the adoption of 4IR technologies by manufacturing SMEs in KZN.

The objectives of this study are supported by a pragmatic methodology, which considerably expands the area of the investigation. 384 manufacturing SMEs in KZN are the target population for this study, and approaches for identification and selection of the sample size include convenience and purposive sampling. The study utilises both primary and secondary research. Interviews and questionnaires are utilised as data collection instruments. The review of literature and relevant theories such as the technology acceptance model (TAM), the technology-organisation-environment (TOE) framework, dynamic capability theory (DCT), the theory of planned behaviour (TPB), task-technology fit, process virtualisation, and the unified theory of acceptance and use of technology (UTAUT) assist in identifying and addressing potential barriers that may arise during the technology adoption process, such as cost, skills, resistance to change, and compatibility with existing systems.

The primary results of this study demonstrate that digital competencies and thorough ICT knowledge are lacking in manufacturing SMEs in KZN. In addition, ICT adoption and usage in manufacturing SMEs in KZN is significantly low, which diminishes the potential of ICT as a long-term strategy. This is evident in the investigation of several factors relating to the acceptance and use of ICT by manufacturing SMEs as a long-term tool for business success. The findings of this study also suggest that manufacturing SMEs do not have the capacity to identify and implement appropriate and adequate ICTs as a sustainable strategy to improve their business viability. Based on the key findings, the study recommends that manufacturing SMEs prioritise digital literacy, which will enhance their comprehension of the potential benefits of ICT adoption. Consultation with IT professionals is recommended as a valuable means for SME owners to obtain reliable guidance and to discuss the complexities of ICT. The government should consider creating platforms to enable SMEs to express objections to regulations, contribute to amendments, and provide insight into the impact of legislation on their business.

Keywords: Manufacturing, SMEs, 4IR technologies, technological innovation, sustainability, KwaZulu-Natal

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LIST OF ABBREVIATIONS

4IR	Fourth Industrial Revolution
AI	Artificial intelligence
AR	Augmented reality
CC	Cloud computing
DCT	Dynamic capability theory
DOI	Diffusion of innovations
DSBD	Department of Small Business Development
DUT	Durban University of Technology
ESP	Entrepreneurship Skills Programme
EU	European Union
GDP	Gross domestic product
GIBS	Gordon Institute of Business Science
ICT	Information and communications technology
IoT	Internet of Things
IT	Information technology
KMO	Kaiser-Meyer-Olkin measure of sampling adequacy
KZN	KwaZulu-Natal
NDP	National Development Plan
NSDP	National Skills Development Programme
OC	Organisational culture
PEOU	Perceived ease of use
RBV	Resource-based view
SEDA	Small Enterprise Development Agency
SME	Small and medium-sized enterprise
SPSS	Statistical Package for the Social Sciences
TAM	Technology acceptance model
TOE	Technology-organisation-environment
TPB	Theory of planned behaviour
TRA	Theory of reasoned action
UTAUT	Unified theory of acceptance and use of technology
VR	Virtual reality

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Introduction

Small and medium-sized enterprises (SMEs) are a key element of the economy in South Africa. Their contributions, which are diverse and significant, impact various aspects of economic growth, job creation, innovation, and social development (Msomi and Olarewaju 2021; Matekenya and Moyo 2022; Mhlongo, van der Poll and Sethibe 2023).

SMEs in South Africa are classified based on their workforce size and the annual revenue they generate (Bvuma and Marnewick 2020; Mishi *et al.* 2023; Zondo and Ncube 2023). Although definitions can vary by industry, small businesses typically have fewer than 50 employees and medium-sized businesses often have between 50 and 200 employees (Masocha 2019; Kharlamov *et al.* 2022; Robertson *et al.* 2022). Studies conducted by Jere and Ngidi (2020) and Mishi *et al.* (2023) note that precise definitions of SMEs may change depending on the government agency, sector, or context in which they are employed. The 2003 and 2004 National Small Business Amendments Acts, which revised the National Small Business Act of 1996, recognises SMEs as separate and distinct legal organisations (Ngibe 2020b). The National Small Business Act of 1996, as modified, acknowledges SMEs' contributions to job creation, revenue generation, and reduction of impoverished conditions (Sixaba and Rogerson 2023; Mhlongo *et al.* 2023; Royal, Singh and Chander 2023). This act provides a legal framework for promoting the development of small businesses and creating an enabling environment for their success (Tshuma 2022; Maziriri, Nyagadza and Chuchu 2022; Mhlongo and Daya 2023).

Daniels, Dosso and Amadi-Echendu (2021) and Kankisingi and Dhliwayo (2022) assert that SMEs are essential for promoting innovation and creativity in South Africa. This is because SMEs contribute to research and development, introduce new products, and find solutions to address local challenges (Ndlela 2022; Saruchera and Mpunzi 2023). As businesses have increasingly grasped the groundbreaking possibilities of cutting-edge technologies, the adoption of information and

communications technology (ICT) has gained traction over the years (Achieng and Malatji 2022; Shola and Victor 2023; Mhlanga, Shava and Dzingirai 2023). In Africa, digitisation initiatives have been implemented across various sectors, including telecommunications, banking and finance, healthcare, agriculture, education, and governance (Meru and Kinoti 2022; Mwaura 2023; Nfuka 2023). In South Africa, the introduction of digitisation by manufacturing SMEs has been noted as a growing trend driven by the need for increased competitiveness and operational efficiency and holds significant potential for economic growth and industrial development (Thakoor 2020; Jeza and Lekhanya 2022; Mazwi 2023). In addition to transforming the manufacturing landscape in South Africa, digitisation offers SMEs opportunities to enhance their processes, products, and overall business performance (Ntuli 2022; Peter, Pradhan and Mbohwa 2023; Makoni and Chikobvu 2023). Embracing digital technologies has the potential to aid manufacturing SMEs in overcoming various challenges, improving efficiency, increasing access to services, fostering innovation, and driving economic growth (Etim and Daramola 2020; Motlounge and Hofisi 2023).

Despite the above-mentioned benefits of digitisation, manufacturing SMEs in South Africa face various challenges including limited access to finance, regulatory burdens, high operating costs, limited access to markets, and skills shortages (Tshuma 2022; Baloyi and Khanyile 2022; Msimango 2023; Mazwi 2023). A combination of these challenges makes it difficult for manufacturing SMEs to sustain their operations and thrive in the long term. Hence, the development of a framework to guide the adoption of technology is essential in ensuring that manufacturing SMEs in South Africa can fully harness the potential of digitisation for sustainable growth and economic development.

1.2 Background

According to Aghimien, Aigbavboa and Matabane (2021), as a developing nation, South Africa's small enterprises have faced significant challenges in adopting new technologies associated with the 4IR). In support of the above assertion, Bessant, Alexander, Tsekouras, Rush and Lamming (2012) discovered that in the mid-2000s, SMEs encountered greater difficulties as advanced technologies such as Computer-Aided Design and Computer-Aided Manufacturing gained traction. This is because the

above stated technologies were found to be prohibitively costly for SMEs to acquire (Scherer 2011). This persistent challenge has been evident with small manufacturing businesses in KZN which are lagging with ICT integration due to expensive costs and the inability to track the technological advancement (Nkosana and Skinner 2016.; Sitharam and Hoque, 2016). As a result, from the year 2008 to 2013, the effects of globalization pushed the South African governments to establish programs that help improve technology adoption by SMEs (Leboea 2017). These initiatives proved ineffective due to an excess of regulations that failed to accommodate the needs of small enterprises in KZN (Ngibe 2020a). Presently, the uptake of 4IR technologies remains minimal due to persisting constraints such as insufficient funds, disparities in skill sets, inadequate infrastructure improvement, and a lack of coherent policy guidance, all of which contribute to reluctance concerning progressing toward sustainable development through business ventures (Motloung 2022; Ntuli 2022). As a result of these ongoing issues, the current study aims to create a framework that would throw light on how manufacturing SMEs might overcome 4IR adoption challenges.

1.3 Problem statement

The substantial number of small business failures is a significant issue that South Africa, like many other emerging countries, must deal with. Studies conducted by Kuhlase (2022) and Mothibi, Warlimont and Nădrag (2022) found that SMEs were more prone to failure within the first five years of their conception. The inability of manufacturing SMEs to thrive, endure, and achieve considerable accomplishment can be attributed to diverse obstacles. In contrast with large firms, failure to innovate by SMEs is a major hindrance that has been attributed to their lack of digital skills to effectively comprehend the potential benefits of utilising ICT (Saruchera and Mpunzi 2023; Mhlanga *et al.* 2023). Challenges with comprehension of government regulatory requirements and a lack of supportive policies for innovation create additional barriers for manufacturing SMEs looking to adopt Fourth Industrial Revolution (4IR) technologies (Ngobe 2023). Although that may be true, Serumaga-Zake and van der Poll (2021) argued that the South African government has introduced various initiatives aimed at promoting the adoption of 4IR technologies by small businesses, which also

catered for the KZN manufacturing sector. These initiatives encompass a range of support measures, such as provision of financial assistance for innovative projects, offering backing for manufacturing activities, and facilitating the upskilling of the workforce in small manufacturing businesses Khuzwayo (2023). Government agencies like the Small Enterprise Development Agency (SEDA) play a crucial role in these efforts, along with programs like Skills Development Grants, Technology Innovation Grants, and the Manufacturing Competitiveness Enhancement Programme (Mhlongo and Daya 2023). Through these initiatives, the government seeks to foster a more technologically advanced and competitive small business sector that KZN SMEs can benefit from (Zhou and Zondo 2023). On contrary, Mhlongo and Daya (2023) established that there are concerns about the effectiveness of government policies and support initiatives in fostering the growth and sustainability of SMEs in KZN. As a result, the noted challenges faced by South African SMEs are further exacerbated by the persisting digital divide and disparities in ICT adoption between industrialised and developing nations (Mhlongo *et al.* 2023). This is because much of the available knowledge on the successful adoption and usage of technology by SMEs is based on the perspective of developed countries (Saka, Chan and Wuni 2022). Despite ample studies conducted in this field, there remains a gap in studies that offer insights pertaining to how technological innovations have been utilised in an African context. This study seeks to develop a framework that will not only guide the adoption of ICT by manufacturing SMEs in KZN, South Africa, but also highlight the challenges associated with technological innovation.

1.4 Aim and objectives

This study aims to develop a framework that can provide practical guidance for the adoption of 4IR technologies by manufacturing SMEs in KZN.

1.4.1 Objectives

- To examine the ways in which 4IR technologies are used in manufacturing SMEs in KZN

- To assess the benefits of adopting 4IR technologies in manufacturing SMEs in KZN
- To assess the barriers to adopting 4IR technologies in manufacturing SMEs in KZN
- To develop practical strategies for overcoming barriers to the implementation of 4IR technologies in SMEs in KZN

1.4.2 Research questions

- In which ways are 4IR technologies used in manufacturing SMEs in KZN?
- How do manufacturing SMEs in KZN leverage 4IR technologies to capitalise on emerging market opportunities?
- Are there specific industry or contextual factors that impede the optimal usage and integration of technological innovations by manufacturing SMEs in KZN?
- What best practices or lessons learned can be identified from SMEs that have effectively navigated and overcome barriers to the adoption of 4IR technologies?

1.5 Significance of the study

The significance of this study on the adoption and usage of 4IR technologies by small businesses in the manufacturing industry is multi-faceted and has implications for various stakeholders.

1.5.1 Manufacturing SMEs and customers

The multidimensional significance of this study's findings could assist manufacturing SMEs to address opportunities and impediments to technological integration and promote strategic planning for long-term viability. In addition, the implementation of technologies in small manufacturing businesses can lead to the creation of innovative products and services for customers. The premise of mutual impact shows that, in exchange for manufacturing SMEs offering their clients goods or services, clients will support the growth and viability of the SMEs through patronage and loyalty.

1.5.2 Policymakers

The outcomes of this study could guide South African policymakers in improving current policies relating to industrial strategy to ensure that they better reflect the objectives of GDP growth, job creation, and income redistribution. This strategic approach could make a major contribution to accomplishing broader provincial and national goals leading to enhanced sustainability of manufacturing SMEs. This could entail modifying legislative frameworks to assist the manufacturing sector more effectively. In addition, utilising the results of this study could direct policymakers in the allocation of funds towards initiatives that target the demands and constraints that manufacturing SMEs confront in implementing innovative technology.

1.5.3 Industry experts

It is envisaged that industry experts would be able to utilise this study's findings to provide more personalised and knowledgeable advice to manufacturing SMEs seeking guidance on the adoption and integration of technological innovations. In addition, the results of this study could point out technological innovation domains where manufacturing SMEs need specialisation, thereby assisting industry experts in customising skill-building programs to meet the changing demands of the sector. It is also envisioned that the outcomes of this study could be used by industry experts to identify significant areas of specialisation and cultivate an attitude of ongoing learning and adaptation.

1.5.4 Higher education institutions

It is envisaged that accredited colleges and universities in South Africa would be able to align their curricula to the technological innovation demands of manufacturing SMEs that are identified in this study. In addition, the findings of this study could serve as a basis for cooperative projects between academic institutions and manufacturing SMEs, thereby establishing beneficial connections that support practical studies and provide effective solutions.

1.5.5 Other researchers

This study is projected to devise an effective framework that merges the proposed solutions regarding the experiences of manufacturing SME managers in relation to technology adoption. This study will further identify areas of future research that other researchers can consider embarking their research on. Moreover, the results from the current study will provide insights to other researchers about the true difficulties and benefits that manufacturing SMEs encounter when adopting technology.

1.6 Research design

According to Toyon (2023), Sharma, Jha *et al.* (2023), and Oberholzer and Buys (2023), a research design is a blueprint that details the actions, methods, and techniques to be followed in acquiring and analysing data in order to answer a particular research question or hypothesis. The significance of a research design can potentially be seen in how it contributes to the accuracy, dependability, and generalisability of the outcomes of the study (Hays and McKibben 2021; Breslin *et al.* 2022). In order to accomplish the goal of this study, preliminary interviews were carried out with information technology (IT) specialists to determine the most recent 4IR support systems available. These initial interviews provided a strong starting point for the study's goals and objectives by drawing on the most up-to-date and relevant technological information.

1.6.1 Population

The population of a study represents a specific group of people, or occurrences with common attributes, of interest to the researcher (Mulisa 2022; Miller, Chng and Cheah 2022; Singh, K.K 2022). It is important to clearly define the population of interest to ensure that the study's findings can be appropriately generalised to the intended group (Ganesha and Aithal 2022; Scheaf *et al.* 2023). However, studying an entire population can be difficult due to its vastness and logistical limitations (Singh, Anvikar and Sinha 2022; Wood *et al.* 2023). As a result, researchers often work with a subset of the population, known as a sample. In this study, the population consists of IT professionals working in the commercial sector, including software developers, systems analysts, website designers, information systems managers, and

specialists in telecommunications or communication networks, as well as managers of manufacturing enterprises in KZN.

1.6.2 Sampling method

Sampling in research is the act of choosing a sample of individuals, entities, or components from an overall population to serve as representatives of that group (Mohajan 2020; Pandey and Pandey 2021; Rahman 2023). Sampling is a practical and effective technique to collect data and make generalisations about the entire population instead of studying every single member of a population (Muzari, Shava and Shonhiwa 2022; Zickar and Keith 2023; Khoa, Hung and Hejsalem-Brahmi 2023).

In this study, a convenience sampling approach is used; participants are chosen depending on their accessibility and convenience. Additionally, this study employs a purposeful sampling technique for the selection of demographics that exhibit certain qualities pertinent to the study.

1.6.3 Data collection instruments

Gathering information or data in a systematic manner in order to address a given research question, test a hypothesis, or accomplish a specified research goal is known as data collection (Ganesha and Aithal 2022; Sukmawati 2023; Toyon 2023). The precision and dependability of the research findings and conclusions hinge on the collection of accurate and high-quality data during research (Reddy, Reddy and Jonnalagadda 2022; Zozus, Kahn and Weiskopf 2023; Hendren *et al.* 2023). Depending on the purpose of the research and the type of data needed, various approaches, strategies, and tools may be used to gather data (Nayak and Narayan 2019; Ahmadin 2022; Maier *et al.* 2023). Conventional data gathering techniques include surveys in which the researcher utilises questionnaires or interviews to gain information from individuals or groups, frequently with structured or semi-structured questions (Ruslin *et al.* 2022; Islam and Aldaihani 2022; Miller *et al.* 2023).

In this study, a mixed methodology is used to obtain a deeper understanding of what is being examined through the collection of numerical data and in-depth information.

The viewpoints of managers of manufacturing SMEs with regard to the incorporation of technological innovation are shown in the quantitative data. A deeper understanding of current technology advancements and integration-related difficulties is obtained through interviews with industry experts.

1.7 Data analysis

Data analysis is a methodical process that involves examining, evaluating, and interpreting the gathered data in order to make sense of it, discover trends, test hypotheses, and respond to research questions (Mohajan 2020; Schweinsberg *et al.* 2021; García-Peñalvo 2022). Data interpretation is an essential phase in the procedure of research as it transforms raw data into information that can be used to shed light on the problem at hand and help to achieve the goals of the study (Carcary 2020; Burdine, Thorne and Sandhu 2021; Hendren *et al.* 2023). Data analysis encompasses a variety of methodologies and methods depending on the research objectives and the type of data collected, which could be quantitative, qualitative, or mixed (Taherdoost 2022; Khoa *et al.* 2023). Regardless of the approach, data analysis aims to provide a clear and logical interpretation of the findings that answers the research questions or tests the stated hypotheses (Schreurs *et al.* 2022; Burnard 2023). Therefore, it is essential to confirm the accuracy, soundness, and dependability of the data analysis process to generate trustworthy and robust results (Dvijotham *et al.* 2023).

In this study, SPSS version 26.0 is used to perform factor analysis and descriptive analysis on the quantitative data. The qualitative data is analysed using the thematic method.

1.8 Pilot testing

A pilot test is a small-scale preliminary study or trial carried out before to the main research effort (Shakir and ur Rahman 2022; Aschbrenner *et al.* 2022; Ullah *et al.* 2023). A pilot study is designed to assess and evaluate the feasibility, practicality, and effectiveness of the research methods, procedures, and data collection tools (Nofrida and Mahmudah 2023; Shewen and Adams 2023). The primary objective of a pilot

study is to identify and address any issues, shortcomings, or defects in the research design before to starting a more in-depth investigation (Swedberg 2020; Brandon David 2023). Pilot tests are used by researchers to assess the efficacy and suitability of data gathering instruments, such as questionnaires, surveys, interviews, and observation protocols (Taherdoost 2021; Sharma 2022; Toyon 2023).

In this study, a small subset of participants who were readily available and willing to participate in the pilot study were identified. In line with Fink's (2013: 44) suggestion that the acceptable number of participants in a pilot study is 10, and to ensure representativity of the larger sample, a survey trial was conducted with 50 manufacturing SME managers and an interview schedule was tested on two IT experts in the commercial sector. This proved beneficial in acquiring extensive knowledge on the factors influencing the utilisation of technology from the perspectives of both the manufacturing managers and IT specialists within the business sector.

1.9 Validity and reliability

Validity assesses the extent to which the results and conclusions accurately reflect the research's intended objectives and the phenomenon being studied (Sürücü and Maslakci 2020; Dodgson 2023). Researchers use a variety of techniques to increase validity, including proper research designs, confounding variable control, operational definitions that are unambiguous, and the selection of representative samples (Wulff *et al.* 2023; Gaertner *et al.* 2023). Reliability pertains to the extent to which measurements or data obtained from a research instrument are coherent, stable, and capable of being repeated (Armour and Williams 2022; Kennedy 2022). In order to ensure that validity and reliability is tested in this study, the questionnaire was sent to research experts to check that the instrument covers all the crucial variables and to ensure that the questions are not ambiguous. In addition, Cronbach's Alpha was used to determine whether the variables measured were stable or constant.

1.10 Ethical considerations

To safeguard the rights, well-being, and honour of the individuals involved, researchers must abide by ethical principles throughout the study (Goldim and Fernandes 2023;

Young and Gonzalez 2023). Additionally, any research involving human beings must take concerns regarding ethics into account to guarantee that it is carried out in a way that is trustworthy and ethical (Husband 2020; Chenneville and Schwartz-Mette 2020).

Ethical approval was obtained from the Faculty Research Ethics Committee of Durban University of Technology (DUT) before the study was conducted. In addition, informed consent was obtained from participants before they participated in the study to ensure that they understood the risks and benefits. Participants were provided with an information letter that explained the purpose of the study, provided a description of the procedures, explained the risks and discomforts to participants, outlined the rewards and payment, and guaranteed the anonymity of participants.

1.10.1 Anonymity and confidentiality

Anonymity refers to the practice of protecting the identities and personal information of research participants (Pietilä *et al.* 2020; Feher 2021; Bhalerao *et al.* 2022; Huang 2023). Anonymity and confidentiality also involves ensuring that any data collected from participants is devoid of any identifying information that could lead to the identification of individuals (Kamanzi and Romania 2019; Favaretto *et al.* 2020; Pascale *et al.* 2022).

In order to maintain participant anonymity and confidentiality in this study, any direct quotes from participants were appropriately anonymised or paraphrased to prevent subjects from being recognised through their words. In addition, to ensure confidentiality of the data gathered, the data was stored securely using encrypted files and password protection. Tight access controls were in place and only persons authorised to work with the data were granted access. To further protect participant identities, the data will be kept securely for a maximum of five years before being disposed of.

1.11 Limitations of the study

This study is limited in that it focuses solely on the manufacturing SME sector in KZN, which is a smaller subset of the overall manufacturing SME sector in South Africa. In

addition, conducting a study on technology adoption and usage in manufacturing SMEs alone may overlook valuable insights and learnings that can be gained from studying other SME sectors across South Africa. This is because other sectors may have different approaches, challenges, and strategies. Additionally, by limiting the study to manufacturing SMEs, the whole spectrum of technological possibilities and problems faced by SMEs in many sectors may not be adequately captured. Furthermore, by omitting to examine technology adoption across all SME sectors, the study could potentially overlook links and synergies between other industries. Conversely, a more complete picture of the whole adoption landscape might be provided by examining how the adoption of technology in the manufacturing sector interacts with or influences the adoption of technology in other SME sectors. Therefore, the findings of this study may not be applicable to all SME sectors as manufacturing SMEs may have different technological needs and constraints compared to SMEs in other sectors such as service, retail, or agriculture across the province of KZN and South Africa as a whole.

In addition, challenges were experienced with conducting data collection due to COVID-19 safety regulations that were imposed, such as maintaining social distance and adhering to stay-at-home guidelines. The majority of the manufacturing SMEs either temporarily ceased operations or were apprehensive about engaging in face-to-face conversations or encounters, which resulted in a delay in data collection. A multi-purpose data collection method was subsequently used to improve the response rate.

1.12 Overview of chapters

This study consists of seven chapters, each serving a distinct purpose. The following outline offers a systematic structure to guide the reader through various aspects of the research exploration.

1.12.1 Chapter One: Introduction and background

Chapter One examines the contribution of small businesses to the manufacturing sector to the economy, the adoption and application of ICT, and the factors influencing technology usage. The chapter identifies a gap in literature that this study seeks to

address. It details the study's objectives and the research methodology employed. The chapter also discusses the limitations encountered during the research, the key assumptions made, and the anticipated impact of the study's findings.

1.12.2 Chapter Two. Literature review

Chapter Two presents an in-depth review of contemporary literature that is pertinent to the South African SME sector with relevance to manufacturing SMEs. The chapter provides insight into the potential benefits and challenges associated with technology adoption by manufacturing SMEs, including factors such as cost considerations, the impact of COVID-19 on manufacturing SME sustenance, interest rates, looting, the impact of government relations on technology adoption, resistance to change, and lack of IT skills and expertise. The significance of reviewing literature on cutting-edge technologies driving the 4IR is discussed in this chapter, along with the potential utilisation of these technologies by SMEs in the manufacturing sector in KZN to foster sustainable development.

1.12.3 Chapter Three. Theoretical framework

Chapter Three presents a thorough summary of pertinent theories, views, and research findings pertaining to the use of technology by SMEs. This information contributes to the establishment of the theoretical foundation for this study and provides a basis for proposing research hypotheses, guiding data collection and analysis, and contributing to the existing knowledge in the field.

1.12.4 Chapter Four: Research methodology

Chapter Four provides an extensive description of this study's techniques and design and validates the methods used to conduct the study. This chapter emphasises the study's objectives and targets, examines the research methodology employed, provides details about the participants, describes the sample collected, and discusses the data gathering tool utilised. The study's ethical principles are also discussed in this chapter.

1.12.5 Chapter Five: Discussion of quantitative and qualitative findings from manufacturing SMEs in KZN

Chapter Five provides a comprehensive analysis of the findings. The findings reveal the rates at which small manufacturing enterprises are employing different technologies, such as online sales platforms, customer relationship management applications, and internet-based data storage. These findings are illustrated by means of numerical figures, such as percentages, to provide an understanding of the level of technology adoption among individuals.

1.12.6 Chapter Six: Discussion of qualitative findings from IT experts

Chapter Six presents a comprehensive examination of the qualitative results obtained from interviews with a diverse group of IT professionals employed in roles such as software developer, systems analyst, and web designer, among others. These conversations played a crucial role in acquiring a profound comprehension of the technological options available to SMEs in the manufacturing sector. The insights obtained from these interviews are organised in thematic categories. This offers a structured presentation of the findings for better clarity and understanding.

1.12.7 Chapter Seven: Conclusions and recommendations

Chapter Seven presents a complete summary of the study's findings as well as a thorough examination of how manufacturing SMEs in KZN are utilising technology. In addition to an in-depth overview of the utilisation of technology within manufacturing SMEs in KZN, this chapter also presents conclusions regarding the variables driving the decisions of adopters, the possible advantages and challenges of technology adoption, and useful guidelines to promote technology adoption and usage. The chapter explains how the findings of this study may assist SMEs, industry support groups, and policy makers in making rational conclusions about adopting modern technologies. It also presents a model for supporting technological innovation among manufacturing SMEs in KZN based on the results and recommendations of this study.

1.13 Conclusion

The first chapter discussed the study's context, specified the challenges involved, and articulated the intended goals and objectives. The significance of the research and the methods used to conduct this study were also discussed. In conclusion, the chapter summary indicates the path that this research will pursue. The next chapter will be reviewing prior studies to better comprehend the problem that is explored in this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The aim of a literature review is to assess the contribution of prior work to better understand the current research problem being investigated. It also serves to identify existing gaps in the literature that the study will help to fill. This chapter reviews existing literature on SMEs and 4IR technologies underpinning this study. It discusses the evolution of SMEs, their contribution to the economy, and their awareness of technologies available for adoption. In addition, the chapter discusses the various technologies driving 4IR, the benefits of the adoption of technology by manufacturing SMEs in developing countries, and the factors inhibiting this adoption. This review of the literature and existing findings will help broaden the understanding of what has transpired in the area of interest in order to better inform the current study.

2.2 International perspective on the background and contribution of manufacturing SMEs towards the economy

The importance of SMEs as a driver of economic development has been widely discussed around the world. SMEs have been referred to as the “seed” of large corporations and the “fuel” of national economic engines (Erdin and Ozkaya 2020: 1). In many developed countries, such as Canada and Japan, SMEs in a broader context have been identified as the “future” of the economy (OECD 2017; Endris and Kassegn 2022; Child, Karmowska and Shenkar 2022). As a result, the recognition of SMEs in European Union (EU) countries has led to policy changes to reduce barriers to their development, resulting not only in the massive expansion of SMEs but also in the sustained prosperity and viability of SMEs in Europe (Rotar, Pamić and Bojnec 2019: 3302). The success noted in European countries has not, however, been achieved in many developing countries. This is because EU countries have paved the way for the comprehension and utilisation of digital technology through educational programs, substantial investments in digital infrastructure, and backing of digital business activities in SMEs (Sanchez-Hughet, Aramendia-Muneta and Erro-Garcés 2022).

SMEs have been found to be crucial to the United States and Massachusetts state economies, as well as to the economies of other affluent countries such as Germany, in sustaining and increasing their manufacturing capabilities (Reynolds and Uygun 2018: 179; Aerni 2021: 3). SMEs have a significant impact on the economy in Russia, where they account for 50% of the gross domestic product (GDP), and significant positive associations have been found between the relative size of SMEs and indicators of economic growth (Gamidullaeva, Vasin and Wise 2020: 260; Oyekan 2022: 7343). In Malaysia, SMEs contribute 38.2% to the GDP (Sana, Poddar and Paul 2020: 18; Wisuttisak 2020: 2; Yuen and Ng 2021: 982), while the GDP contribution of SMEs in Japan is 70.2% (Oliveira *et al.* 2022: 3; Davletyarov, Suyunov and Kenzhabaev 2023: 7). In advanced economies, SMEs encounter less financial and economic barriers to their development (Mallinguh, Wasike and Zoltan 2020: 2; Khan 2022: 40).

In developing nations such as Kenya and Nigeria, SMEs account for a substantial percentage of the GDP ranging from 20% to 47% (Enddris and Kassegn 2022: 21; Wachira 2022: 12; Aitaa 2023: 79; Roy *et al.* 2023; Simatele *et al.* 2022: 321). Notwithstanding the widespread presence of SMEs in several industries, including manufacturing, services, distributive trade, and agriculture, their economic contributions vary (Roxas 2021: 8; Oanh *et al.* 2021: 285). In some countries, such as Sri Lanka and Vietnam, although SMEs are important for economic development and revenue distribution, their overall influence on the economy may not always match their prevalence (Fonseka, Jaharadak and Raman 2022; Heenkenda *et al.* 2022: 1; Siah and Chan 2022). This is because manufacturing SMEs in developing nations face challenges that impede their ability to adopt technology (Vanninen, Keränen and Kuivalainen 2022: 3). These challenges have resulted in manufacturing SMEs in developing countries operating just below the technical frontier (Abisuga-Oyekunle, Patra and Muchie 2020: 411; Peerally *et al.* 2022: 3). Moreover, the economic hardships faced by many developing nations act as a formidable barrier to the adoption of 4IR technologies by SMEs in the manufacturing sector (Wee 2023).

2.3 Background of manufacturing SMEs in South Africa

There has been a great deal of debate about the value of manufacturing SMEs as a driver of economic expansion in South Africa (Fubah and Moos 2022: 1; Saruchera and Mpunzi 2023: 2). This is because manufacturing SMEs are recognised by the South African government as a crucial tool for redressing apartheid legacy patterns of business ownership, particularly in rural areas (Furawo and Scheepers 2018: 3; Matubatuba 2022; Cader and Mazhazha-Nyandoro 2023). Mhlanga, D (2022a) and Mncube and Ratshisusu (2023) assert that this is due to the fact that manufacturing SMEs give historically underprivileged individuals and societies a chance to engage in economic activity. The National Development Plan (NDP) envisages that manufacturing SMEs engage in national economic initiatives intended to boost economic growth, create jobs, reduce poverty, and accelerate socioeconomic transformation (SEDA 2018: 12; Zhou and Gumbo 2021; Jonck and Nwosu 2022). This plan envisages that by 2030, South Africa's manufacturing SMEs will provide 90% of employment (Bhorat *et al.* 2018; Lukhele and Soumonni 2021). The manufacturing sector makes up approximately 12% of South Africa's economy (Gaglio, Kraemer-Mbula and Lorenz 2022). Manufacturing, which supports revenue expansion and alleviates the impact of economic crises, is the fourth-largest industry in South Africa (Maisiri and van Dyk 2021: 2). KwaZulu-Natal's manufacturing industry is the second largest in the country, and almost a third of South Africa's manufactured exports are produced in KZN (Ngibe and Lekhanye 2019; Naidoo *et al.* 2022). The SME sector makes up about 35% of South Africa's GDP (Kankisingi and Dhliwayo 2022: 2). eThekweni is the highest contributor to KZN's GDP, with its total national contribution being 17% (PWC 2022). However, it appears that South African manufacturing SMEs, particularly those in KZN, struggle to grow and achieve long-term economic stability (Ngibe 2020a: 1; Mkhize 2022; Hlatywayo 2022).

To bring about radical transformation, manufacturing SMEs in KZN should be visible through their contribution to and betterment of their immediate communities as well as their contribution to the local economy through employment (Jili, Masuku and Selepe 2017; Mulaudzi 2020; Nleya 2020). Naicke and Rajaram (2018) emphasise the essentiality of the advancement of the execution of effective support structures for manufacturing SME development by the South African government.

2.4 Contribution of SMEs to the South African economy

Bvuma and Marnewick (2020: 5) cited the 2003 and 2004 National Small Business Amendments Acts, which characterize an SMME as a distinct enterprise run by one or numerous individuals that must satisfy certain conditions. The progressive contribution of manufacturing SMEs in South Africa, including those in the textile, plastic, and automotive industries, is crucial to the country's economic growth, the reduction of poverty, and the creation of jobs (Masocha 2019: 1). Consequently, South Africa's SMEs are a crucial component of change and have a substantial impact on the stability of the economy (Naradda Gamage *et al.* 2020; Madiba and Madikizela 2022; Shilomboleni *et al.* 2022). A study conducted by Saah (2021) established that SMEs boost the GDP and economic growth. The South African government has shown an interest in the economic performance of eThekweni, where approximately 11% of the national value of manufacturing activities is produced (Robbins and Velia 2016: 12; Mkhize, Mthembu and Napier 2023; Mncube, Adelabu and Adagbasa 2023). KZN's former Premier, Mr Mchunu, highlighted in his State of the Province Address that in an attempt to eradicate the 38.6% unemployment rate, the manufacturing sector was identified as one of the key drivers of economic development that is expected to bring about radical transformation and economic growth in the province (Buthelezi 2020). Statistics South Africa (2023) found that there had been a surge in production in 40% of manufacturing industries, particularly in food and beverages and in petroleum, chemicals, rubber, and plastics. Studies conducted by Kuhlase (2022: 2) and Mhlongo *et al.* (2023: 3) established that contributions by SMEs to the South African economy have improved and that SMEs comprised over 90% of commercial spaces, nearly 70% of jobs, and 55% of the GDP. Therefore, SMEs' agility and responsiveness to market demands make them an important driver of economic development and diversification (Letebele 2020; Zhou 2021).

SMEs' adaptability to market demands and flexibility foster innovative thinking and the creation of innovative products, services, and business models (Mamabolo and Reddy 2021; Makuwe 2021; Jeza and Lekhanya 2022). SMEs involved in sectors such as manufacturing, agriculture, and services can expand their market reach beyond domestic boundaries and contribute to foreign exchange earnings (Kaplinsky and Morris 2019; Makoni and Chikobvu 2023). This is as a result of manufacturing SMEs'

ability to contribute to regional development by creating economic opportunities outside of major urban centers (Mkhize 2020; Makhaye *et al.* 2021; Sixaba and Rogerson 2023). In addition, manufacturing SMEs have been found to stimulate economic activity and infrastructure development in rural and underdeveloped areas, thereby reducing regional disparities (Redders 2021; Potts *et al.* 2022). By fostering a conducive environment for SMEs, South Africa can harness their potential to drive economic growth, job creation, and socio-economic transformation (Shilangu 2019; Habiyaemye, King and Tregenna 2022). This can be accomplished by enhancing regional economies, reducing unemployment, and reducing poverty through the development of manufacturing SMEs in remote areas where job opportunities may be limited (Ngwane and Cebekhulu 2020; Jubane 2022; Vivagum Govender 2022).

Manufacturing SMEs in KZN have often been found to have had a multiplier effect on local economies (Ngibe 2020a: 39). This is because manufacturing SMEs contribute to the growth of supporting industries, such as raw material suppliers, logistics services, and packaging providers (Zeidy 2020; Reddy 2021; Chinomona and Bikissa-Macongue 2022). Manufacturing SMEs' contribution to the growth of supporting industries leads to the development of local supply chains and fosters economic activity in rural areas (Makhaye and Subban 2021; Mokoena and Liambo 2023). In addition, manufacturing SMEs have the ability drive innovation and technology transfer, leading to the development of new products, processes, and technologies (Prasanna *et al.* 2019; Kruger and Steyn 2020). Hence, South African SMEs are crucial to the growth of new and innovative sectors, driving competitiveness and eroding traditional market monopolies in certain industries (Amesho *et al.* 2022; Mmbengwa 2022; Feyen, Natarajan and Saal 2023).

However, the South African government, investors, and policymakers have been concerned about the declining contribution of SMEs to the GDP in recent years and particularly about their reluctance to adopt technology, which has necessitated extra support for the development and long-term expansion of manufacturing SMEs in the country (Ngibe 2020a: 1; Duma 2023; Mkhize and Nel-Sanders 2023). Changes in manufacturing processes have necessitated that manufacturing SMEs embrace technological change in order to grow and improve productivity (Kaplinsky and Morris 2019: 1; Mhlongo *et al.* 2023; Ndlovu and Mewomo 2023). Thus, the economy's

growth and the equitable distribution of wealth rely greatly on small businesses (Blose 2018; Mhlongo and Daya 2023).

2.5 Challenges impacting manufacturing SMEs in South Africa

Although SMEs have been recognised globally as significant economic contributors, these entities, as compared to large firms, face challenges that threaten their survival (Bushe 2019; Msomi, Ngibe and Bingwa 2020; Mungal 2020). The obstacles that manufacturing SMEs confront may be within or outside of the business environment, which significantly influences a firm's endurance and longevity (Bvuma and Marnewick 2020: 5; Maharajh 2021; Masabo 2021). The challenges that impede the sustainability of manufacturing SMEs are discussed below.

2.5.1 Poor economic status

South Africa is a country marked by high levels of impoverishment and income disparities (Webster and Francis 2019; Moyo, Mishi and Ncwadi 2022). South Africa has been found to be one of the most inequitable countries in the world, with approximately 57% of its citizens living below the poverty line and an unemployment rate of around 29% (Dauderstädt 2022; Shah 2022). These issues are rooted in the country's history of racial discrimination and oppression (Nguse 2022; Xaba and Akinola 2022; Mntambo, Adebayo and Ndinda 2023). Despite ambitious reform efforts made by the South African government, economic growth remains slow, and the level of poverty and inequality remains extremely high (Akanle, Kayode and Abolade 2022; Silander 2022; Swilling *et al.* 2022). As a result, the economy of South Africa is divided between a wealthy minority and a large population of poor people (Koelble 2022; Davids *et al.* 2023).

South Africa's poor economic status has been further exacerbated by a high level of corruption, which has had a detrimental effect on the economy (Syed *et al.* 2022; Alexander *et al.* 2022; Francolini *et al.* 2023). This has deterred investment meant to resuscitate the economy of South Africa (Mamokhere 2022). South Africa's negative GDP growth rate has suggested a slowdown or contraction in economic activity (Khambule 2022b; Buthelezi, E.M 2023; Mbelu 2023). High rates of unemployment, which show that a sizable percentage of people are unable to find work, are indicative

of South Africa's poor economic position (Mottiar and Magwaza 2023; Moses and Woolard 2023; Mbatha *et al.* 2023). All of this points to a dearth of prospects for manufacturing SMEs, declining income levels, and dwindling confidence levels among SMEs (Gumede and Napier 2022; Bhebhe *et al.* 2023; Mbandlwa 2023).

In light of the above, manufacturing SMEs have had to limit their investment in expansion and new initiatives, which has resulted in slower economic development and fewer job openings (Zamani 2022; Hasseno 2023). More importantly, high levels of government debt are a contributing factor to the strained economy, as they result in higher taxes and reduced public spending (Baporikar 2021; Seidman Makgetla 2021; Jubane 2022). High levels of government debt further limit the government's ability to stimulate the economy and may negatively impact investor confidence (De Villiers, Cerbone and Van Zijl 2020; Hlongwane and Daw 2023). South Africa has also struggled to maintain sound economic policies that promote economic growth and development (Mutengwa, Mkeni and Kondwakwenda 2023; Rogerson and Rogerson 2023).

2.5.1.1 Impact of a poor economy on technology adoption

A poor economy can both positively and negatively influence an SME's decision to adopt ICT (Taylor 2019; Munongo and Pooe 2022; Agwaniru 2023). During an economic downturn, SMEs often face financial constraints, including reduced cash flow, limited access to credit, and tighter budgets (Johnson 2022; Hasseno 2023; Mohezar, Mohamad and Mohd Nor 2023). These financial limitations can make it challenging for manufacturing SMEs to invest in ICT infrastructure, software, or equipment, which may be perceived as costly (Mbonyane, Mbohwa and Pretorius 2023; Ndhlovu and Dube 2023; Saruchera and Mpunzi 2023). The upfront costs associated with ICT adoption can deter manufacturing SMEs from making investments during times of economic uncertainty (Zahra, Dhewanto and Utama 2021; Gwala and Mashau 2023; Collin and Veena 2023).

On the other hand, a poor economy may also push SMEs to adopt ICT as a means to reduce costs and improve efficiency (Msomi and Olarewaju 2022; Saruchera and Mpunzi 2023). Operational efficiencies, process automation, and resource allocation

can all be improved by implementing ICT solutions such as customer relationship management software and cloud-based applications (Saruchera and Mpunzi 2023). In addition, embracing ICT can potentially assist manufacturing SMEs to lower operating costs and achieve greater productivity, thus enabling them to weather economic challenges (Mkhize 2022; Mtshali and Jili 2022). ICT adoption by manufacturing SMEs can also open up new market opportunities (Zamani 2022). Through digital platforms and e-commerce channels, manufacturing SMEs are likely to expand their customer base beyond local markets and tap into national or even global markets (Berndt 2022; Mukosa 2022; Ramsern and Baxodirovna 2023). This can be particularly relevant during a poor economic situation when local demand may be limited (Ndlela 2022; Kasumpa 2022). SMEs in KZN can reach a larger consumer base and diversify their revenue streams by utilising ICT (Hornby 2020; Garatsa and Dlamini 2021). In addition, embracing ICT can enhance a manufacturing SME's competitiveness by enabling it to offer better products or services, improve customer experience, and adapt to changing market dynamics (Jeza and Lekhanya 2022; Nyamapanda 2022; Rasmussen and Petersen 2023).

A poor economy can create an environment that demands innovation and adaptability from manufacturing SMEs (Ismail 2022). Therefore, adopting ICT enables manufacturing SMEs to innovate their business models, products, or services to address changing customer needs or market dynamics (Ntuli 2022; Rasmussen and Petersen 2023). ICT adoption requires manufacturing SMEs to acquire new skills or enhance their existing skills (Makhaye and Subban 2021; Mhlongo and Daya 2023). During a poor economic situation, manufacturing SMEs may be more cautious about investing in employee training due to limited resources (Geza *et al* 2022; Matlay, Hussain and Millman 2023; Kandolo 2023). However, economic challenges may also motivate manufacturing SMEs to upskill or reskill their workforce to leverage ICT effectively and remain competitive (Masheleni 2022; Mlambo 2022). It is advisable for manufacturing SMEs to consider training programs or incentives offered by governments or industry associations to support SMEs in this regard (Buthelezi, E.M 2023; Mkhwanazi 2023; Takyi, Naidoo and Dogbe 2022). Thus, the impact of a poor economy on technology adoption decisions in SMEs depends on several factors, including the SMEs' specific circumstances, available resources, market conditions,

and the perceived benefits and costs of ICT adoption (Gwala and Mashau 2023; Nowar 2023; Saruchera and Mpunzi 2023).

2.5.2 Security challenges

South Africa's high crime rate is a major roadblock to economic growth and stability (Kesar and Jena 2022; Van der Waldt and Fourie 2022). The high prevalence of violent crime, property crime, and organised crime has created a largely uncertain environment for manufacturing SMEs to operate and for investors to invest in South Africa (Maluleke and Dlamini 2019; Marais, Cloete and Lenka 2022; Shah 2022). These volatile circumstances can reduce investment in the economy, which results in fewer job opportunities, more poverty and a lack of economic development (Jubane 2022; Zungu and Mtshengu 2023). Crime also significantly impacts the cost of doing business in South Africa (Mhlongo and Daya 2023). Due to high levels of crime, manufacturing SMEs need to invest in security measures such as entrances, cameras, and guards, which reduces their profits and increases the cost of goods and services (Ashiyana 2022; Jacobs, David and Stiglingh-Van Wyk 2023; Hlongwane 2023; Msosa 2023). In addition, crime puts a strain on public funds that could otherwise be used to combat poverty through job creation and economic development initiatives (Herbig 2019; Makhaye and Subban 2021; Mazenda *et al.* 2022). When resources are diverted to dealing with crime, fewer resources are available to invest in economic development initiatives which can create jobs, unlock human capital, and stimulate growth (Marek *et al.* 2020; Odeku 2021).

2.5.2.1 Looting

The rampant looting that occurred in KZN during 2021 had a deep and wide-ranging impact on the region's small businesses, including manufacturing SMEs. This was evident in a decline in trading activities, which had a devastating impact on the local economy (Geldenhuys 2021; Mhlongu 2021; Visser, Rangongo and Esterhuizen 2021). Many SMEs had their properties and stock damaged or looted, and some were forced to close due to losses and safety concerns (Cinini and Mkhize 2021; Mongale 2022). Small businesses in the manufacturing sector were particularly vulnerable to

looting due to their lack of financial buffers and resources (Mamabolo and Reddy 2021; Mafuwane 2023).

The looting and destruction of property in KZN had a devastating effect on SMEs (Dlamini 2021; Mafuwane 2023). Looting had a severe financial impact on these businesses, some of which were unable to sustain their operations and were forced to close (Amankwah-Amoah, Khan and Wood 2021; Bhoola 2022). Many of the affected businesses had already been facing difficulties prior to the looting due to the commercial slump caused by the COVID-19 pandemic (Desai 2022; Makanishe and Umubyeyi 2023). Losses from looting have been estimated to cost SMEs in KZN over R1.1 billion; this has been detrimental to SMEs which had already been struggling in the current economic downturn (Kamdar 2021; Mundhree and Beharry-Ramraj 2022). The effects of looting have included reduced production and service output, stockpiles of unsold goods, damage to premises, financial losses, and displacement of workers (Modiba 2022; Mbatha *et al.* 2023). As a result, some manufacturing SMEs were unable to continue operations, which resulted in job losses and consequently reduced the number of income earners in KZN (Mahaye, Dlomo and Ajani 2023; Shumba, Trinos and Gopal 2023). This in turn has had a negative impact on the local economy; SMEs have received fewer orders as people have not been able to afford to purchase goods and services (Majoko and Dudu 2023). Because the profitability of manufacturing SMEs was diminished as a result of the looting, they were unable to replenish their stock or invest in new capital goods (Mbatha *et al.* 2023; Shabalala 2023). The looting of small and medium-sized manufacturers in KZN has had a detrimental impact on the economy and has been detrimental to SMEs that were already fragile (Turok, Seeliger and Visagie 2021; Struckmann 2023). As a result of the looting and damage to property, these manufacturing SMEs have had to deal with losses of merchandise and maintenance costs (Mongale 2022; Van den Nouwelant and Cibin 2022; Mdlalose 2023).

The South African economy, which had already been in a vulnerable state, suffered even more due to the looting of manufacturing SMEs in KZN (Hofmeyr *et al.* 2022; Shumba *et al.* 2023). Many of the affected businesses were unable to obtain assistance to repair the damages, leaving them without a viable source of income (Brown *et al.* 2022; Mbandlwa 2023). This caused a ripple effect within the

manufacturing sector of KZN, as losses associated with the looting of these businesses resulted in delayed payments to suppliers, unemployment of staff, and reduced consumer spending (Pill 2022; Majoko and Dudu 2023). The disruption to SMEs not only resulted in an immediate loss of economic activity but has also had the long-term economic impact of a lack in business continuity (Ani and Uwizeyimana 2022; Ogunnubi and Aja 2022). This has led to interruptions in job creation, tax revenue generation, supply chains, and ultimately the aggregate economic growth of the country (Uwizeyimana 2021; Hlophe and Matema 2022).

In response to the looting, many local governments and organisations instituted measures to provide aid in the form of emergency funding and support to SMEs that were affected (Van den Nouwelant and Cibin 2022; Mafuwane 2023). Additionally, many organisations advocated for the implementation of support systems such as quality economic advice and legal protection (Turok and Visagie 2022; Zulu *et al.* 2022). Small firms and informal manufacturers that were looted or vandalised during the July 2021 riots were encouraged to apply for business recovery support packages (Vhumbunu 2021). These initiatives were intended to assist the affected businesses to continue operating and mitigate the long-term economic implications of the looting (Ikoyive 2022; Rakubu, Masuku and Madima 2023). However, studies conducted by Childs *et al.* (2022) and Le and Nguyen (2022) found that the support packages had not been dispersed as promised.

The above-mentioned issues highlight the need to focus on the development of an infrastructure that is resilient to disruptions such as looting (Ariza-Montobbio, Carrión and Delgado-Ramos 2022; Andresen *et al.* 2023). This can be achieved by improving access to resources that can help SMEs mitigate the negative economic effects of looting (Mtotywa *et al.* 2022; Baldin 2023). The effects of the civil unrest and looting that occurred from 9 July 2021 to 18 July 2021 in KZN and Gauteng highlight the importance of examining the implications of these riots on ICT adoption by SMEs (Business Leadership South Africa 2021). A study conducted by Tembe and Hlengwa (2022) found that potential investors may lose confidence in the reliability of the small business environment due to incidents of looting and riots. As a result, obtaining funding or establishing partnerships to leverage modern technology and foster growth

may be challenging for manufacturing SMEs (Mathenjwa 2023; Reddy and Mamabolo 2023).

2.5.3 Impact of COVID-19

The outbreak of COVID-19 had a direct and immediate impact on manufacturing SMEs in KZN (Khoza, Adeniyi and Ayandibu 2022; Gwala and Mashau 2023). A substantial number of manufacturing SMEs depend substantially on their supply chains, and as many of these firms' primary suppliers saw a sharp decline in their output or the closure of their operations, supply chain disruptions occurred (Mundhree and Beharry-Ramraj 2022; Bianco *et al.* 2023). Manufacturing SMEs in KZN experienced challenges in sourcing raw materials, components, or finished goods from suppliers, which led to production delays and increased costs (Reddy 2021; Khoza, Adeniyi and Ayandibu 2022; Mkhize 2022). Lockdowns, travel restrictions, and economic uncertainty resulted in reduced consumer demand (Khan, Su and Zhu 2022; Thwala and Dube 2023). Manufacturing SMEs saw a decline in orders and contracts, which affected their revenue streams and overall business viability (Mhlungu 2021; Gwala and Mashau 2023). The implementation of lockdown measures and social distancing guidelines led to difficulties in maintaining normal operations (Baporikar 2021; Mohammed 2022; Njomane and Telukdarie 2022). SMEs in KZN faced workforce disruptions due to employees falling ill, quarantine requirements, and concerns regarding workplace safety (Khambule 2021; Mbele 2022).

The economic downturn caused by the pandemic resulted in financial challenges for manufacturing SMEs in KZN (Maharaj and Reddy 2020; Makhaye and Subban 2021; Maureen, Olushola and Ayandibu 2022). With the closure of many businesses, many SMEs experienced a drastic decrease in their income or a complete loss of revenue (Njomane and Telukdarie 2022; Alarifi and Adam 2023). As a result, manufacturing SMEs in KZN faced difficulties in accessing capital, managing cash flow, paying wages, and meeting other financial obligations (Naicker 2020; Nkwinika and Mashau 2020). The negative impact of COVID-19 on manufacturing SMEs adversely affected the ailing economy of South Africa, which resulted in multiple downgrades by credit rating companies (Meyer *et al.* 2022; Mukwakwa 2022; Rajagopaul, Magwentshu and Kalidas 2020: 3). Therefore, the sustainability of SMEs is a significant challenge for

the South African economy (Naicker and Rajaram 2019; Ayandibu *et al.* 2019; Oguiuba 2021).

The COVID-19 pandemic highlighted the importance of digitalisation and remote work (Hutchings 2020; Crawford and Cifuentes-Faura 2022). Manufacturing SMEs that were not adequately prepared for remote operations or lacked digital infrastructure faced additional challenges in adapting their business models to the changing circumstances (Parker, Morris and Hofmeyr 2020; Mamabolo and Reddy 2021).

Despite being severely impacted by the COVID-19 pandemic, SMEs have demonstrated resilience, adaptability, and creativity in the years following the pandemic (Naidoo 2021; Fubah and Moos 2022; Mundhree and Beharry-Ramraj 2022; Nzama 2023). The pandemic also resulted in an upsurge in the use of digital technologies and online platforms in South Africa (Mbunge *et al.* 2022; Mhlanga, Denhere and Moloji 2022).

2.5.4 Infrastructural challenges

Infrastructure refers to the physical framework of the facilities used to deliver products and services to the general population (Macháč, Brabec and Arnberger 2022; Feldman 2023). It includes fundamental physical and logistical systems, such as transportation systems, communication systems, water and power lines, that are required for the smooth operation of businesses (Khawaja 2022; Mukherjee *et al.* 2023). Infrastructure is crucial to the functioning of a society, as it provides the foundation for businesses and other enterprises to thrive (Jeza and Lekhanya 2022; Hlongwane 2023). Roads, buildings, and public transportation are all critical to harnessing economic viability and allowing citizens to travel freely (Khambule, Nomdo and Siswana 2019: 57).

Lack of infrastructure has been identified as an inhibiting factor to the adoption of 4IR technology by manufacturing SMEs; as inadequate digital infrastructure results in challenges for manufacturing SMEs to integrate and use cutting-edge technologies in their manufacturing procedures, investment in infrastructure is needed (SEDA 2018: 7; Gaal and Afrah 2017).

2.5.4.1 Lack of consistent supply of electricity

Manufacturing SMEs in KZN have been affected by infrastructural issues that have the potential to disrupt their daily operations (Olajuyin and Mago 2022; Tembe and Hlengwa 2022). This puts an immense financial strain on manufacturing SMEs that are unable to operate effectively due to disruptions caused by infrastructural issues (Mafuya 2022; Ijoma *et al.* 2022; Mkhwebane 2022). Eskom's monopoly on electricity supply has resulted in high electricity costs which also have a negative impact on small businesses (Bailey 2022; Murwirapachena, Kabange and Ifeacho 2022). As a result, small businesses have had to devote a massive portion of their revenue to electricity, which has reduced their overall profits (Aberdeen 2022; Buthelezi, E.M 2023; Hasseno 2023). High electricity costs have reduced the budgets of SMEs and hindered their potential for growth (Johnson 2022; Petersen 2022; Zulu, Ngwenya and Zondi 2023).

According to a report by Nedbank (2023: 8), manufacturing SMEs in South Africa have shed 83% of jobs and spent between approximately R11 000 and R500 000 per month on additional costs due to loadshedding. Consequently, these SMEs have had to consider strategies that will require less electricity for production processes (Nedbank 2023: 11). This has forced many SMEs to invest in generators and other backup equipment to remain operational (Dunn 2022).

The ability of manufacturing SMEs to access facilities and equipment has been found to result in their improved operation and potential growth (Sharma, Raut *et al.* 2023). In addition to facilitating operations, infrastructure is vital for gaining competencies (Khambule *et al.* 2019: 57).

2.5.4.2 Lack of Internet connectivity

A lack of suitable infrastructure has made it difficult for South African SMEs to adopt technology efficiently (Pillay 2016: 42; Nkosi 2021; Georgeu-Pepper 2022). An out-of-date telecommunications infrastructure, restricted access to electricity, and ineffective infrastructural policy enforcement have all been found to contribute to non-adoption of

technology (Kaiser and Barstow 2022; Kuteyi and Winkler 2022; Khine and Langkulsen 2023). Infrastructural challenges are particularly pronounced in rural areas, where the ability to fully utilise digital tools for business operations and growth is hindered (Peter and Meyer 2022; Mpabanga 2022; Brown *et al.* 2022). These challenges have been found to have a negative impact on the competitiveness of manufacturing SMEs (Matsepe and van der Lingen 2022; Mtotywa *et al.* 2022; Mathibe, Muchenje and Masonta 2023). A report issued by the South African Institution of Civil Engineering in 2022/3 indicates that ineffective policies have exacerbated these challenges, which if left unaddressed could potentially result in South Africa becoming a “failed state” (Anthony 2023). Access to technology can only be increased if issues such as telecommunications costs and the availability of ICT infrastructure are appropriately addressed (Pillay 2016; Njomane and Telukdarie 2022; Richardson, Meyer and Von Solms 2022).

2.5.4.3 Lack of access to new technologies

SMEs lack resources such as finance, technology, trained personnel, and networks, and their transaction costs are high (Al Buraiki and Khan 2018: 4; Makanyeza, Mabenge and Ngorora-Madzimure 2023). The costs of hardware and software are a significant barrier to technology adoption in SMEs, and innovations that are perceived to be inexpensive are more likely to be adopted (Prause 2019: 6; Nkosana 2022; Mdoda and Mdiya 2022). If manufacturing SMEs perceive ICT adoption costs as expensive, they are less likely to adopt the technology (Cant and Wiid 2016: 1878; Amini and Jahanbakhsh Javid 2023; Ndhlovu and Dube 2023). In addition, the adoption of advanced manufacturing technologies is strongly related to the degree of market uncertainty or unpredictability of the market environment (Prause 2019: 9).

The cost of maintaining a company’s technology rises as it ages and deteriorates (Mallinguh *et al.* 2020: 1; Romero, Fernández-Serrano and Cáceres-Carrasco 2023). Due to technological development, both new capital and maintenance costs vary over the life of a fixed asset (Ahmed, A.Y 2022; Gwala and Mashau 2023). As technological complexity increases, businesses should establish adaptable technology development and knowledge acquisition strategies (Gartner, Maresch and Tierney 2022; Wided 2023).

2.5.5 Government support

Government support initiatives and policies play a crucial role in the constantly evolving and intricate environment of manufacturing SMEs (Takyi *et al.* 2022). These initiatives act as vital accelerators for SME growth by offering crucial tools, direction, and incentives that enable SMEs to overcome obstacles and make major contributions to the economy (Malapane and Mukonza 2023). However, the efficacy of governmental assistance and capacity development programmes is limited because they lack specificity, and as a result they fail to offer tailored solutions to the challenges of individual SMEs (Zhou and Zondo 2023b).

This section examines the support agencies available to manufacturing SMEs and analyses the efficacy of legislative frameworks intended to foster SME development. It also discusses the diverse methods by which the government provides support and offers training initiatives to advance the skills and capabilities of SMEs.

2.5.5.1 Training and capacity development workshops

In South Africa, there are numerous government programmes and initiatives aimed at assisting SMEs to enhance their skills and capabilities through training and support (Rabie, Cant and Wiid 2016). These are offered by government institutions such as the Department of Small Business Development (DSBD), the Small Enterprise Development Agency (SEDA), the Department of Trade and Industry, and the National Youth Development Agency (Kelly *et al.* 2021; Ramasimu, Majadibodu and Ladzani 2023).

A training development workshop is a planned and interactive learning experience designed to enhance the skills, knowledge, and capabilities of participants in a specific area or discipline (Dladla and Mutambara 2022; Mhlongo and Daya 2023; Priyana and Syam 2023). Government training programmes aim to enhance the business skills and capabilities of SME owners and employees (Teka 2022: 6; Edelia and Aslami 2022: 35; Nguyen *et al.* 2023: 2). The purpose of government training and development

programmes for SMEs is to support and enhance the growth and competitiveness of these businesses (Adam and Krishna 2022; Magodi, Daniyan and Mpofo 2022; Rambaruth *et al.* 2023). The process includes educating manufacturing SMEs on subjects such as handling finances, product promotion, employee management, task handling, and future planning (Kumar *et al.* 2022; Mkhonza and Sifolo 2022; Roopchund 2023). By improving these skills, manufacturing SMEs can make informed decisions, improve efficiency, and adapt to changing market conditions (Hasseno 2023; Msomi and Kandolo 2023; Mutambara 2023).

Government training programmes are also designed to assist manufacturing SMEs in understanding and accessing various financing options, grants, subsidies, and support services available to them (Bamata and Phiri 2022; Mkhwanazi 2023). This helps manufacturing SMEs overcome financial barriers, invest in growth, and expand their operations (Soni *et al.* 2022; Sharma, Joshi *et al.* 2023).

By supporting the development and growth of SMEs, government training programs can contribute to the overall economic development of a region or country (Singh, Charan and Chattopadhyay 2022; Zhou and Zondo 2023b; Zulu *et al.* 2023). A strong and growing SME sector boosts employment, fosters innovation, and encourages entrepreneurship, which results in a diverse and resilient economy (Iwara and Kilonzo 2022; Bag 2023).

2.5.5.2 Support agencies for manufacturing SMEs

The South African government has implemented a beneficial strategy aimed at assisting and fostering the growth of SMEs to ensure their success and maximise their capabilities (Baloyi and Khanyile 2022; Fubah and Moos 2022). This has been achieved through the development of a Small Business Policy, which was largely influenced by the White Paper on National Strategy for the Development and Promotion of Small Businesses in South Africa published in 1995 (Sibiya and Kele 2019; Shackleton *et al.* 2022; Mensah and Derera 2023). The South African Small Business Policy is part of a wider government strategy designed to foster pro-enterprise conditions conducive to entrepreneurial initiation, development, sustainability, and growth (Bushe 2019; McKenzie 2021; Rogerson and Rogerson

2021). The deployment of support agencies by the South African government creates an encouraging environment for the development of businesses (Muriithi 2017: 8; Meyburgh 2022; Acheampong and Rand 2023).

In addition, local governments have established institutions and policies to aid the long-term viability of SMEs (Fatoki 2021; Ismail 2022; Sheik and Kader 2022). These organisations were created solely to assist the development of manufacturing SMEs through various funding schemes and incubators in order to strengthen the South African economy, accelerate SME growth and success, and create jobs (Rogerson 2018; Lose 2019).

In an attempt to create an enabling environment, SEDA was established by the Department of Trade and Industry to advance, assist, and encourage SMEs in South Africa to secure their progress and continuity (Litheko and Potgieter 2020; Botha *et al.* 2021; Ngcobo and Khumalo 2022). In addition, the South African government has invested in the capacity development of SMEs by providing numerous training and workshop initiatives (Geza *et al.* 2022; Saleh *et al.* 2022). SEDA is one of a number of government initiatives intended to provide training and implementation of research projects to support the development of manufacturing SMEs in South Africa (Mayombe 2023; Ndlovu and Mewomo 2023; Smit and Pretorius 2023). SEDA's programmes focus on providing training, knowledge transfer, research, market access, access to finance, and business advisory services to enable small and micro businesses to become profitable and sustainable (Dzimba and van der Poll 2022; Nyathi 2022; Engel *et al.* 2023). SEDA also aims to facilitate the establishment and enhancement of small business clusters, thereby increasing the competitiveness of businesses within the clusters (Cishe, Mpongwana and Kativhu 2022; Ndlela 2022; Sihlobo and Mbatha 2022). This enables manufacturing SMEs to develop the competencies and systems to move from the informal sector towards a more formal status in the economy (Jubane 2022; Dzimba and van der Poll 2022; Maduku and Zerihun 2022; Mkhwanazi 2023). The training and skills development services provided by SEDA also encourage entrepreneurs to start and manage businesses (Svenson 2021; Ngcobo and Khumalo 2022; Zhou and Zondo 2023b). However, the efficacy of SEDA's initiatives in promoting the expansion and advancement of small businesses has been found to be inconsistent (Mkhwanazi 2023; Ramsuraj 2023). While SEDA has provided small businesses with invaluable resources and support, there are still obstacles in turning

these efforts into long-term economic benefits. One criticism is that SEDA's programmes do not sufficiently target underprivileged populations or isolated areas where entrepreneurship support is most required (Dzimba and van der Poll 2022; Mazwi 2023). Furthermore, the scope and depth of SEDA's influence have been hampered by bureaucratic inefficiencies and insufficient finance, which have made it more difficult for the organisation to significantly spur economic growth and the creation of jobs (Akoh 2023; Sibiya, van der Westhuizen and Sibiya 2023).

The National Skills Development Programme (NSDP) is another government initiative that provides training to equip SME owners with the knowledge and competencies required for employment in business (Nyamande-Pitso 2022; Malapane and Mukonza 2023). The NSDP seeks to promote entrepreneurship by providing practical and theoretical business training to prospective SME owners interested in setting up their own businesses (Bvuma and Marnewick 2020; Fourie and Malan 2021). In addition to job training, the programme encourages lifelong learning through diversity programmes and access to educational opportunities (Rabapane 2020; Ntuli 2022; Van der Westhuizen 2023). This creates an environment conducive to the creation of new businesses and job opportunities (Mokoena 2019; Gamede 2020; Maphiri, Matasane and Mudimu 2021). However, the efficacy of the NSDP is impeded by a multitude of obstacles (Chattopadhyay, Singh and Gupte 2023). These include restricted availability of training materials, especially in underprivileged areas; administrative obstacles that hinder programme involvement; and insufficient post-training assistance to guarantee the utilisation of learned competencies (Kaur 2020; Rahman, Bhattacharjee and Rahman 2021). Furthermore, there are discrepancies between the skills offered by the training programme and prevailing demands of the industry which limit manufacturing SMEs' ability to create jobs and support sustainable growth (Nkwanyana 2022; Letsie 2023).

The Entrepreneurship Skills Programme (ESP) aims to provide young business owners with the abilities and social networks essential for achieving success in entrepreneurial ventures (Zaki, Al Muwali and Mahdi 2021; Masha *et al.* 2022; Ngcongco and Ramraj 2022). This programme is specifically tailored to entrepreneurs and targets the areas in which they need development (Iwara and Kilonzo 2022; Maziriri *et al.* 2022). Similarly to SEDA and the NSDP, the ESP consists of workshops

and mentoring initiatives designed to improve specific skill sets such as business planning, marketing, and financial management (Em, Khan and Nun 2022; Wulandari 2022). The ESP also provides mentorship to assist entrepreneurs in navigating the often difficult terrain of starting a business (Laalje 2020; Nleya 2020; Sishi 2022). Ultimately, the programme aims to provide entrepreneurs with the skills to build sustainable businesses that will benefit their communities (Wagner *et al.* 2021; Cele and Williamson 2022; Zulu *et al.* 2023). The ESP has been shown to be effective in encouraging innovation and providing SMEs with the tools needed to succeed in their respective industries (Amin 2021; Ngwenya and Boya 2023). However, the ESP's efficacy has been hampered by accessibility issues, as certain SMEs in isolated areas have had difficulties participating in the programme (Ntibane 2021; Amankwah-Amoah *et al.* 2023).

The DSBD aims to offer a wide range of capacity development programmes and services to SMEs in South Africa (Farisani 2022; Mokoena 2022; Tshuma 2022). These services are provided at no charge and include workshops, seminars, and online resources aimed at assisting SMEs understand their legal and tax obligations (Dlamini 2022; Mkhwanazi 2023). In addition, the DSBD's programmes teach SMEs how to acquire financing, improve their operations, develop their marketing and sales plans, and improve their management and leadership abilities (Babalwa Soga 2022; Modiba and Mago 2022; Buthelezi, L.L 2023; Mkhwanazi 2023). Through its variety of initiatives and grants, the DSBD has achieved great progress toward fostering the expansion and long-term viability of small businesses (Mhlongo and Daya 2023; Mkhwanazi 2023). Despite this, constraints still exist that reduce the efficiency of DSBD's programmes. The extent and influence of the DSBD's initiatives have been limited by a lack of resources and financial assistance which has kept the agency from reaching a larger group of small enterprises and prospective entrepreneurs (Rabonda 2023; Saah 2021).

2.5.5.3 Policy framework

The implementation of the policy framework to support small businesses in South Africa is contingent on various aspects. One key strength of the policy framework is to acknowledge the crucial contribution of small businesses to fostering economic growth

(Mhlongo and Daya 2023). It includes policies such as the Small Business Policy, which prioritises assisting current owners of small businesses, including those in manufacturing, to attain their objectives and to address some of the difficulties they encounter (Kamberidou 2020; Andreoni and Tregenna 2020; Aruleba and Jere 2022). This policy seeks to simplify the path to success for small businesses by giving them an opportunity to actively participate within the formal economy and promoting the generation of stable employment (Elvin Shava 2022; Geza *et al.* 2022; Mncube and Ratshisusu 2023). The policy encompasses various strategies aimed at streamlining the administrative burden for small enterprises, simplifying the tax structure, and enhancing their opportunities for training and financial assistance (Cishe *et al.* 2022; Mporu 2022; Mhlongo and Daya 2023). In addition to implementing support schemes designed to benefit SMEs, the government has also provided incentives for the adoption of technologies that optimise their operations and capabilities (Kansheba 2020; Matekenya and Moyo 2022). The policy seeks to promote an efficient and effective regulatory framework that is tailored to the specific needs of SME owners (Mohammed and Bunyaminu 2022; Modiba and Mago 2022; Buda and Ricz 2023).

While the South African government has implemented policies to promote SMEs in the country, there are several shortfalls and challenges that hinder the effectiveness of these policies (Ouma-Mugabe, Chan and Marais 2021; Rambaruth, Adam and Krishna 2022; Beraki *et al.* 2022). Despite government initiatives, many SMEs, including those in the manufacturing sector, continue to struggle to access funding due to stringent requirements, high interest rates, and a lack of collateral (Nyathi 2022). Access to affordable and adequate financing continues to be a significant challenge that impedes the sustainability of SMEs in South Africa (Nkwinika and Mashau 2020; Teka 2022). This is due to the regulatory environment in South Africa, which is complex and burdensome for manufacturing SMEs (Naicker and Rajaram 2019; Mohamed, Yasseen and Nkhi 2020; Zhou and Zondo 2023a). Compliance with various laws, regulations, and bureaucratic processes is time-consuming and costly for manufacturing SMEs (Peeters and Nieto-Morales 2021; Croucamp and Croucamp 2022; Kweezi and Barakagira 2023). A lack of clarity, administrative delays, and inconsistent application of regulations pose barriers for SMEs, discouraging their growth and inhibiting their ability to compete effectively (Dlamini 2020; Mntambo 2021; Rens *et al.* 2021).

While the South African government provides some business development support, including training programs and advisory services, the coverage and effectiveness of these services remain limited (Gaglio *et al.* 2022; Lambin and Nyssölä 2022; Mokgomo, Chagwiza and Tshilowa 2022; Van der Walt *et al.* 2023). Insufficient resources and a lack of coordination among different support agencies hamper the impact of these programs (Nyahunda, Tirivangasi and Mabila 2022; Toure *et al.* 2022). A substantial proportion of SMEs in South Africa operate in the informal economy and face challenges such as limited access to formal financing, exclusion from government support programs, and a lack of legal protection (Maduku and Zerihun 2022; Dlamini, Iwu and Ogunlela 2023). Despite provision of assistance to SMEs, there is still a significant skills gap in South Africa which affects the growth and productivity of SMEs (Msomi, Yearwood and Msomi 2022). Limited access to quality education and training, particularly in rural areas, hampers the development of skilled entrepreneurs and workers (Brunello and Wruuck 2021; Madonono and Barnard 2020; Ndhlovu 2022).

It is of vital importance that the government provide tailored and specialised interventions to SMEs during and after the aftermath of the COVID-19 pandemic (Rajagopaul *et al.* 2020; Dlamini *et al.* 2023; Kandolo 2023). Some SMEs require funding for ICT adoption, while others require longer-term assistance following the COVID-19 pandemic (Rajagopaul *et al.* 2020; Bugwandin 2022; Collin and Veena 2023; Nzama 2023). There has been limited adoption of new technologies by SMEs, and many SME owners and incubators still operate under traditional business models (Lose and Kapondoro 2020: 8276). Although the South African government supports capacity development workshops for SMEs, the budget allocated to make them available is often constrained (Baloyi and Khanyile 2022; Besada 2022). In addition, government support to promote the development of SMEs is largely focused on providing access to financial assistance schemes, rather than offering ICT advice and mentorship (Dlamini *et al.* 2023; Mayombe 2023; Mkansi and Nsakanda 2023).

Another contributing factor to the ineffectiveness of the assistance programmes provided is the lack of awareness amongst SME owners and entrepreneurs of the available capacity development workshops and their value, resulting in low uptake of these workshops (Kankisingi and Dhliwayo 2022; Sheik and Kader 2022; Collin and

Veena 2023). Despite the efforts of the government to assist SMEs, manufacturing SMEs often lack the necessary networks to provide and access capacity development opportunities (Khunoethe 2021; Musabayana, Mutambara and Ngwenya 2023; Hasseno 2023; Selvarajah, Sukunesan and Meyer 2023). Manufacturing SMEs struggle to access capacity development opportunities due to their size and lack of resources (Mungal 2020; Mthethwa 2021; Maureen *et al.* 2022).

Government regulations with regard to the establishment and running of capacity development programmes can be complex and bureaucratic, which can be a significant disincentive for SMEs to engage with them (Moyo 2019; Zwane 2020; Ndlovu 2021). In the 2015-2016 Global Entrepreneurship Monitor report, South African government support concerning policies, tax, and bureaucracy received a rating of 3.1 out of 9 (Herrington, Kew and Mwanga 2015). This rating suggests that South African laws, legal regulations, and bureaucracy hinder the launch and growth of businesses (Maduku and Zerihun 2022: 8). This rating also indicates a lack of economic stability and security and that businesses may not be competitive in the global market (Mpofu and Sibindi 2022; Vilakazi and Ponte 2022). Thus, the South African government has made some progress towards a more suitable business environment, but much more work needs to be done to advance the ease of doing business in South Africa (Herrington and Coduras 2019; Dube 2020).

2.5.6 Financial challenges

Newly established SMEs in South Africa have been found to have a failure rate of 75%; this has been attributed to various obstacles, including a lack of access to external capital (Fatoki 2014: 748; Khoza, Adeniyi and Ayandibu 2022; Maureen *et al.* 2022). The survival and success of most manufacturing SMEs relies on developing financing and fund-raising plans, understanding available financing options, and obtaining funds (Daka 2022; Magangxa 2022). Since SMEs are unable to obtain financial assistance from the formal credit market, they rely on informal lenders who charge exorbitantly (Mpofu and Sibindi 2022; Msomi and Olarewaju 2022). To address this issue, substantial reform of business credit regulations and the strengthening of debt enforcement and commercial bankruptcy procedures are required (Singh, Chauhan and Jادیyappa 2022). These regulations, norms, and frameworks have

grown increasingly important since the 2008 financial crisis as a form of risk management and compliance (Bushe 2019; Bezuidenhout 2022). The government is accountable for highlighting the significance of SMEs in the development of the nation, and its policy framework for financing and supporting SMEs is critical in addressing the above-mentioned challenges (Nel and Lewis 2022; Al Buraiki and Khan 2018: 3; Van Wyk 2022; Mallingu *et al.* 2020: 2). Insufficient government support and inadequate funding pose significant challenges for SMEs and hinder their growth prospects (Khan 2022). The government plays a critical role in helping to prevent the failure of SMEs so that they can perform to their full potential and contribute to economic development (Ladzani 2022; Bobek, Schachl and Horvat 2023; Boucher, Cullen and Calitz 2023).

Studies conducted by Chetty, Beharry-Ramraj and Gurayah (2022) and Fubah and Moos (2022) propose that the government implement initiatives to address the lack of financial resources that SMEs face in order for them to be able to pursue innovations. Such initiatives would also help SMEs to minimise risks, maximise profits, and ensure their sustainability (Bunclark and Barcellos-Paula 2021). Studies conducted by Abraham, Schneider and Vom Brocke (2019: 425) and Kazancoglu *et al.* 2021: 593) recommend that the government's policy framework include procedures for monitoring governance processes and performance, reviewing organisational objectives, and setting strategies for governance improvement.

A review of the government's policy for financing and supporting SMEs found that government support agencies had been ineffective in offering financial assistance to manufacturing SMEs (Msomi, Ngibe and Nyide 2019: 5; Akoh 2023; Zulu *et al.* 2023). In addition, the contribution of SMEs to economic growth has remained stagnant, which has prevented cooperatives from becoming financially viable and sustainable firms (Mkhwanazi 2023). To ensure that neglected manufacturing SMEs are provided with specialised financial assistance, the government should consider adapting its initiatives to suit the specific needs of SMEs and provide preferential support to SMEs in vulnerable positions (Mthusamy 2022: 40; Ndlovu 2018).

2.5.6.1 Credit management

Small businesses in the manufacturing sector have been found to often encounter challenges in managing their credit (Fungwe and Kabubi 2019; Gyimah, Akande and Muzindutsi 2022). SME owners who lack financial expertise have been found to encounter challenges in creating budgets and effectively allocating funds for technology adoption (Gumata 2022; Zungu, Makhoba and Greyling 2022). In addition, such SME owners have experienced challenges in crafting efficient business plans and precise financial predictions that satisfy lenders' expectations (Agnello, Castro and Sousa 2020; Stein 2021).

The ability of manufacturing SMEs to embrace new technologies is dependent on the availability of finance (Makuwe 2021; Nunden *et al.* 2022). In addition, the inability to negotiate pricing has been found to prevent manufacturing SMEs from obtaining favourable contracts for technological services (Bezemer *et al.* 2023; Raza *et al.* 2023). Such factors highlight the importance of the relationship between credit management and technology adoption in manufacturing SMEs (Duca, Muellbauer and Murphy 2021; Stockhammer 2022).

2.5.6.2 Interest hikes

Financial costs are a crucial factor in decision making in manufacturing SMEs in KZN (Kandolo 2023; Mhlongo and Daya 2023). Studies conducted by Dumitriu *et al.* (2019), Teka (2022), and Hlongwane (2023) found that little progress had been made towards achieving SME sustainability despite loans being made available for this purpose. Manufacturing SMEs and innovators have been found to rely extensively on debt to support their initial investments, ongoing costs, and operating necessities, and their most typical external funding source is bank financing (Bamata 2018; Brown and Lee 2019; Hagin and Caesar 2021). Manufacturing SMEs that apply for loans from banks are required to pay interest, which is a cost associated with possessions that are subject to debt (Ahmed, A.Y 2022; Bwembya 2022; Dlamini 2022). Studies conducted by Khambule (2022b), Otto (2022), and Schutte and Barbeau (2022) found that the loan recovery efficiency rate of SMEs in South Africa has shown a concerning trend.

This has led to SMEs failing to secure subsequent financing, which has exacerbated their existing financial issues (Nunden *et al.* 2022).

Due to the considerable financial obligations of manufacturing SMEs, rising interest rates have discouraged the expansion of such firms (Dlamini 2022; Logose 2022). Fluctuating loan interest rates and strict loan repayment policies from banks have been found to be the main causes of SME failure (Yamori 2019; Msomi and Olarewaju 2022; Nunden *et al.* 2022). The impact of interest hikes on manufacturing SMEs has been found to be multi-faceted (Siyaya 2021; Chetty 2022; Dlamini 2022). Due to the increased cost of borrowing money from banks and other financial institutions for purchasing raw materials and production equipment, operational costs of manufacturing SMEs have increased (Nxumalo 2021; Maureen *et al.* 2022; Khoza, Adeniyi and Ayandibu 2022). In addition, there has been a decrease in the liquidity of manufacturing SMEs as they have been unable to service existing debt liabilities without an increase in their revenue (Marimuthu 2021; Sadiq *et al.* 2021). For manufacturing SMEs in KZN, high interest rates have resulted in defaults and reduced profits, which have led to cash flow difficulties (Msomi and Maharaj 2022; Ntuli 2022). Interest rate increases have deterred manufacturing SMEs from taking on the goal of growing and increasing their production capacity (Thabet 2021; Sheik and Kader 2022). In addition, rising interest rates have limited the capacity of manufacturing SMEs in KZN to stay competitive in the market (Cele, Nyide and Stainbank 2022; Jeza and Lekhanya 2022; Mkhize 2022).

Studies conducted by Madondo (2018), Hornby (2020), and Baker, Judge, and Klein (2022) found that manufacturing SMEs in KZN had requested and received loans to replenish their capital, but that the excessive costs associated with these loans had restricted their overall efficacy and efficiency. Factors such as a drawn-out loan application process, bureaucracy, and inefficient distribution techniques have been linked to the sluggish impact of credit on SMEs (Thomas 2021; Maseke and Liseli 2022). In 2020, the South African government restricted the rate of interest on lending facilities to not more than 10% of the treasury bill due to concerns regarding interest rates (De Villiers *et al.* 2020; Odeku 2020). While this has had the benefit of reducing borrowing costs and increasing the accessibility of financing, concerns have been

raised about the potential lack of profitability in specific saving and investment options (De Villiers *et al.* 2020).

The impact of interest rate hikes on the adoption of technology by manufacturing SMEs in KZN is dependent on the effect of such hikes on their financial stability (Msomi and Olarewaju 2021; Mkhize 2022). If an interest rate hike causes an increase in the costs of borrowing and other financial obligations, this affects a firm's ability to finance the adoption of modern technologies (Madichie, Mpiti and Rambe 2019; Hagin and Caesar 2021). The costs associated with introducing a new technology may become too prohibitive for a firm to justify, which results in a decrease in the adoption of new technologies (Chetty 2022; Nkosana 2022). However, with better loan terms, manufacturing SMEs could be more willing to invest in the technologies required to enhance their competitiveness (Gietema 2022; Kantor 2022; Latham and Prowle 2022).

2.5.7 Lack of awareness of technological platforms

To be able to adopt technology in their firms, SME owners require relevant knowledge; however, many SME owners have experienced challenges in obtaining access to simple ICT solutions and related training (Aruleba and Jere 2022; Takavarasha *et al.* 2023). As technology adoption is not a standardised process for all manufacturing SMEs, a broad understanding of digital technology is critical; the belief that technology adoption can be standardised has been shown to result in the failure of SMEs (Selase *et al.* 2019: 2; Yacob, Peter and Chin 2022; Al-Faouri *et al.* 2023). In a small firm, the majority of decisions regarding the adoption and use of technology depend on the firm's awareness of technologies and the costs associated with them (Ismail 2023; Manjengwa, Dorfling and Tadie 2023). Studies conducted by Gumbi and Twinomurinzi (2020: 42), Matsepe and van der Lingen (2022), and Malomane, Musonda and Okoro (2022) identified awareness of 4IR technologies as the first stage in the process of adopting such technologies.

Studies conducted by Makola (2022), Rambaruth *et al.* (2022) and Mthiyane, van der Poll and Tshehla (2022) highlighted a lack of technological awareness in SMEs in KZN which has been attributed to various factors, including failure to recognise the benefits

of modern technology, technology integration problems, inevitable faults, and power outages. SMEs have been found to be reluctant to adopt new technologies because this would require them to adapt their procedures, train employees, and address associated safety risks, which would impede fundamental business operations (Ndlela 2022; Onwugbolu 2022; Mkhwanazi 2023).

SMEs play a significant role in driving creativity, innovation, and economic growth (Hlatywayo 2022; Tshishonga 2022; Rena 2023). However, studies conducted by Moraka (2021), Monethi (2022), and Ncubukezi (2022) found that manufacturing SMEs were highly vulnerable to cyberattacks and emphasise the necessity of creating awareness among SMEs of the importance of cybersecurity. Studies conducted by Ndlela (2022), Mayombe (2023), and Makanyeza *et al.* (2023) identified education, in conjunction with appropriate technology solutions, as the most effective way to drive cybersecurity awareness amongst SMEs. However, studies conducted by Bakhit (2021) and Mhlongo *et al.* (2023) found that owners of manufacturing SMEs in KZN have neglected to take the essential steps to understand the critical nature of ICT security, accept responsibility for implementing changes, and lead the way in educating their staff about cybersecurity. Provision of training and resources to aid manufacturing SMEs in understanding the importance of cybersecurity is important in driving awareness in this regard (Bada and Nurse 2019; Naicker 2020; Murphy *et al.* 2022). Furthermore, it is important to ensure that manufacturing SMEs remain up to date with the latest security measures, technologies, and legislation (Ntuli 2022; Thango 2022; Zamani 2022).

For manufacturing SMEs to learn about the latest trends in technologies, the ability to develop relationships with other firms is crucial (Mutero and Chummun 2022; Gwala and Mashau 2023). Studies conducted by Ndlela (2022) and Nakwafila *et al.* (2023) recommend enlisting the aid of experts from top ICT vendors to gain knowledge about current and future technological trends. Research and industry events that are focused on emerging technologies can also provide insights into a firm's future direction (Ntusi 2021; Khoza, Adeniyi and Ayandibu 2022; Zhou and Zondo 2023a).

Online learning platforms can enable manufacturing SMEs that are financially strained to stay up to date with the latest developments in ICT (Ngidi 2019; Ngibe 2020b; Etim

and Daramola 2023). Online resources on cutting-edge developments in technology and applications in the manufacturing industry, such as blogs, forums, and journals, can also be helpful (Mhlongo *et al.* 2023; Hoosain *et al.* 2023). Regular Internet research and participation in webinars and other online events related to technology have been found to assist in bringing about much-needed ICT adoption (Molebatsi 2021; Berndt 2022).

The sustainability of SMEs has been found to depend on market research initiatives that determine how their competitors are using ICTs (Govender 2022; Aberdeen 2022). Without the appropriate tools to stay up to date with modern technologies, manufacturing SMEs may be less efficient and competitive than competitors that have adopted the latest technologies. Failure to keep up to date with changes in technology may result in higher costs associated with outdated or inefficient technologies or equipment (Mtshali and Jili 2022; Mchunu 2022). This also results in SMEs falling behind competitors that use the latest technologies (Gomwe, Potgieter and Litheko 2022; Ismail 2022; Zamani 2022).

2.5.8 Organisational culture

The culture of an organisation reflects behavioural patterns and circumstances and affects its perception of the benefits of ICT adoption (Khadrouf *et al.* 2018; Henning and Van der Poll 2022; Joseph, Totawar and Sam 2022; Clark *et al.* 2023). A lack of digital culture in SMEs has been found to influence their decisions regarding the adoption of 4IR technologies (Aghimien, Aigbavboa and Matabane 2019: 351; Matsepe and van der Lingen 2022; Thekkoote 2023). Studies conducted by Kumar, Mangla and Kumar (2022) and Etim and Daramola (2023) found that resistance to the adoption of a technology was often caused by a lack of knowledge about how the technology would be integrated, the complexity of the technology, and the inability to assess the technology before adopting it.

Organisational culture (OC) has been found to be a determining factor that affects how manufacturing SMEs develop and promote innovative ideas internally (Ali and Miraz 2015: 116; Mhlanga, D 2022a; Buruca 2023). SMEs with a flexible OC have been found to be more innovative and aware of the effects of the 4IR on OC; they support

improvements and innovations and drive managers to engage in new activities and to modify their views (Khadrouf *et al.* 2018; Nkosi 2021; Munongo and Pooe 2022). The implementation of 4IR technologies modifies daily operational activities, which in turn has an impact on OC (Serumaga-Zake and van der Poll 2021; Strielkowski *et al.* 2022).

Studies conducted by Amthor (2022), and Seetharam (2022) use the Competing Values Model to demonstrate that understanding of innovation is imperative for change in OC. In most cases, South African manufacturing SMEs have been found to accept innovation and technology if it is relevant and linked with the firm's essential principles, can meet the firm's requirements, and is in line with the firm's corporate culture (Hasani, O'Reilly *et al.* 2023; Msimango 2023; Zondo 2023). Manufacturing SMEs' practices regarding ICT adoption may be influenced by OC constructs such as perceived norms, values, and attitudes (Manning *et al.* 2023; Thabakgolo 2023).

2.5.9 Firm size

The size of a firm can have a significant impact on its ability to adopt technology successfully (Hlatywayo 2022). Smaller firms are often at a disadvantage when it comes to acquiring modern technology due to their limited resources and budgets (Naidoo 2022; Shabalala 2023). Large enterprises grow more quickly than SMEs because they have access to financing and a much more qualified workforce (Mishi *et al.* 2023; Naidoo 2023). Larger firms may also have more access to knowledge and expertise related to the latest technologies (Ncube and Lekhanya 2023; Amini and Jahanbakhsh Javid 2023). Manufacturing SMEs face more resource constraints than large enterprises, which inhibits their ability to be innovative (Collin and Veena 2023; Mbonyane *et al.* 2023).

Due to a lack of resources, SMEs have had to develop innovative tactics to fulfil ever-changing customer needs (Khoza, Adeniyi and Ayandibu 2022; Mutambara 2023). In order to meet customer expectations, SMEs must be able to anticipate market trends. While the use of developing technologies such as cloud computing (CC) is an innovative strategy to achieve this, the size of a firm has an impact on how quickly it adopts such technologies (Soni *et al.* 2022; Venter and Duffett 2022; Mdletshe, Tlapana and Hawkins-Mofokeng 2023; Saruchera and Mpunzi 2023). Due to their size,

SMEs often face numerous challenges in acquiring innovative technologies (Khoza, Adeniyi and Ayandibu 2022; Maureen *et al.* 2022). These challenges include higher capital costs, lack of access to information and resources, and limited staff expertise (Msomi, Olarewaju and Ngcobo 2021; Cele *et al.* 2022). In addition, manufacturing SMEs have been found to lack the staff expertise required to implement ICT (Nondaba 2021; Nunden *et al.* 2022). As a result, these SMEs may be confined to using outdated technology, which can lead to competitive disadvantage in a rapidly changing manufacturing environment (Onu and Mbohwa 2021; Ngibe 2020b).

2.6 Innovation capacity in manufacturing SMEs

In today's competitive and fast-paced market, ongoing creativity is required for innovation (Meng, Qamruzzaman and Adow 2021: 2). For SMEs, innovation entails the ability not only to create new products using technology but also to produce them (Adam and Alarifi 2021: 3). The ability to develop and coordinate the innovation process, as well as to employ innovation input to produce innovation output, is referred to as innovation capacity (Pierre and Fernandez 2017: 140). Kankisingi and Dhliwayo (2022) differentiate between distinct types of innovation in terms of products and services, production methods, suppliers and markets, and organisational strategies. In SMEs, critical decision-making processes such as prioritisation of innovation projects may be less rational and more reliant on a manager's personal beliefs (Ibarra *et al.* 2020: 2). Hossain (2015: 3) notes that even though licensing SMEs' knowledge to other parties is advantageous to them, it does not generate short-term financial benefits. The goal of innovation should be to increase the levels of customer service and corporate competitiveness of manufacturing SMEs in South Africa in the long term (Kankisingi and Dhliwayo 2022).

Manufacturing strategy development in SMEs is a largely untapped resource (Löfving, Säfsten and Winroth 2014: 4). The majority of studies on business model innovation have focused on large corporations, and only a few have focused on SMEs (Hidayat, Bismo and Basri 2020: 4427), hence the need for this study. A study conducted by Ngibe (2020a: 1) emphasises the importance of the relationship between the organisational structure of SMEs and the ability to either stimulate or resist innovation. This calls for an understanding of the conditions under which SMEs formulate

manufacturing strategies and the criteria that make strategic frameworks useful (Löfving *et al.* 2014: 2). A study conducted by Pierre and Fernandez (2017) found the innovation capacity of SMEs to be a useful measure for evaluating their innovative activities and, indirectly, their innovation performance.

SMEs are important stakeholders in increasing innovation, competitiveness, and job creation. In advanced nations, innovation by SMEs is at the core of a successful innovation framework (Zafar and Mustafa 2017). This study was conducted at a time in South African history when, in addition to the economy being in a slump, the COVID-19 outbreak put tremendous strain on all enterprises in unexpected and unimaginable ways, causing utter economic chaos (Chapman 2021: 43).

2.6.1 Level of education of SME managers

Education is among the most commonly researched innovation variables. Educational background is vital to innovative leadership as it facilitates interaction with a business's functional domains (Ngibe 2020a: 44). SME owners with higher levels of knowledge and expertise tend to excel at identifying, obtaining, and comprehending information regarding growth opportunities for their businesses (Peters and Brijlal 2011: 5). The capacity of experienced and educated SME owners in a company is critical to the adoption of technology (Cant, Wiid and Hung 2015: 446). Managers of SMEs should have the expertise and the ability to analyse all the factors that contribute to and inhibit technology adoption (Peters and Brijlal 2011: 5).

In South Africa, limited access to capital and a lack of entrepreneurial education, business knowledge, and leadership are barriers to SME innovation and business creation (Lekhanya 2015: 410). A study conducted by Mahohoma (2018: 20) found that SME owners lacked adequate management and leadership qualifications, which influenced their perceptions of how their businesses should operate in the sector. A lack of knowledgeable business owners who are capable of mobilising and coordinating production inputs has been found to be the biggest impediment to economic growth in poor countries (Lekhanya 2016b). A study conducted by Mahohoma (2020) found that only a small percentage of SME owners had the capabilities required to design a strong business strategy due to a lack of formal and

vocational education and technological skills. A study conducted by Furawo and Scheepers (2018: 38) identified a shortage of leadership and managerial abilities in the SME sector with regard to the management of creative ideas and innovation capability.

Despite the South African government's focus on SMEs, very little has been accomplished in terms of assisting these businesses (Moos and Sambo 2018: 3). This has been attributed to a deficiency in supportive infrastructure for start-ups, a lack of start-up and managerial skills, and the Small Business Development Ministry's deficient performance (Moos and Sambo, 2018: 4). SMEs have been found to lack not only financial resources but also knowledge, talent, and entrepreneurial abilities; this implies that financial institutions that lend money to uneducated business owners with little managerial experience are squandering their capital (Lekhanya 2016a: 58). These findings indicate that education is crucial to the success of manufacturing SMEs as well as to their adoption of technology. Lekhanya (2015: 411) notes that enterprise education seeks to promote enterprising habits, skills, and traits linked with self-sufficiency.

The support of management is vital for the implementation of 4IR technologies, and managers are more likely to implement 4IR technologies if they can see the benefits of doing so (Maduku, Mpinganjira and Duh 2016). A study conducted by Abualrob and Kang (2016) found that the adoption of inexpensive technologies was more likely to receive management support. A study conducted by Furawo and Scheepers (2018: 38) highlights the importance of a participative leadership culture, which is produced by strong leaders whose support for innovation eventually fosters a creative atmosphere throughout the organisation. This suggests that management support of innovation results in an understanding of the necessity of education in enabling the implementation of new technologies.

A study conducted by Prause (2019: 4) uses the technology acceptance model (TAM) to show that technology adoption is often negatively correlated with complexity, which is the degree to which technologies are seen as difficult to understand and utilise. When SME owners perceive a technology to be complex, they also perceive it as risky to adopt, and are therefore reluctant to adopt it (Jere and Ngidi 2020). A further factor

detering SME owners from adopting innovative technology is the belief that sending personnel for the necessary training would be lengthy and prohibitively expensive (Jere and Ngidi 2020). Prause (2019: 5) found that the more compatible a technology was with an organisation's current practices and technological infrastructure, the more likely it was to be adopted. Therefore, the most crucial factors for South African manufacturing SMEs to consider when planning to adopt a new technology are the benefits of the new technology and the organisation's ability to integrate the new technology with its existing technology (Ngidi 2019: 35).

2.6.2 Competence of SME managers

There is no universally accepted definition of management ability. Tarwirei (2015: 55) describes management efficiency as a collection of knowledge, attitudes, and abilities that contribute to individual efficiency. Management competencies include factors such as management proficiency, educational background, expertise, and prior entrepreneurial experience that contribute to a positive impact on the success of a firm (Sitharam and Hoque 2016: 278). Management support is critical in SMEs as the owners and managers of a firm have a considerable influence on the firm's strategies and organisational goals (Jere and Ngidi 2020).

Due to a shortage of skills to run sophisticated ICTs, manufacturing SMEs tend to purchase technology that they perceive as being easy to use (Pillay 2016). Ardjouman (2014: 183) notes that SMEs have limited numbers of personnel with the necessary technical competence to adopt and use innovative technologies. If an SME owner believes that a technology can only be implemented by specialist personnel, a lack of technically knowledgeable employees in the organisation may prohibit or hinder acceptance and usage of the technology (Ardjouman 2014: 183). Therefore, the critical involvement and motivation of management are vital to encouraging the use of innovations (Gono, Harindranath and Özcan 2016: 15; Neicu *et al.* 2020: 2). In particular, the support of top management is essential for the implementation of new technologies in a firm (Hussein *et al.* 2019: 413). Management can assist with the implementation of technologies by providing training and resources, which are critical tools for improving employee morale (Schachtebeck and Nieuwenhuizen 2015: 673).

Training enables manufacturing SMEs to increase product innovation and equip employees with the ability to recognise market shortages (Maes and Sels 2014). To increase the adoption rate of 4IR technologies, manufacturing SMEs should determine the digital skills required and hire ICT specialists to offer training (Rad, Diaby and Rana 2017). To ensure that sufficient training is provided, collaboration between the government and other stakeholders is essential (Bvuma and Marnewick 2020: 5). Training and development are critical because they enable not only the learning of job-related competencies but also changes in attitudes and behaviours related to the use of technology (Rabie *et al.* 2016: 1010). Manufacturing SMEs should include training as part of their strategic plan in order to remain competitive (Ipinnaiye, Dinneen and Lenihan 2017). A study conducted by Lee (2016: 6) found lack of education to be an inhibiting factor to technology adoption; hence, there is a need for training that addresses the technological needs of SMEs.

2.6.3 Adoption of cloud computing

Technology adoption is the foundation for driving strategic purposes across numerous business sectors in South Africa's current digital environment (Motema and Appiah 2019: 1; Mhlanga *et al.* 2022; Tabane 2022). The growth of 4IR technologies suggestively influences how businesses operate in South Africa (Vally 2020; Mabiza 2022). Cloud computing allows South African SMEs to compete technologically with their larger counterparts on a pay-as-you-go basis without making a major upfront financial investment (Amini and Jahanbakhsh Javid 2023).

In developing nations, and particularly in South Africa, the rate of CC adoption in SMEs has been fairly low (Barnett 2022). Lack of awareness of CC and its advantages is one of the main factors contributing to the low rate of CC adoption in South African SMEs (Adane 2022; Shibambu 2022; Thobejane, Mogale and Esiefarienrhe 2022). Other contributing factors include lack of technical support, lack of cloud-ready applications, and lack of vendor readiness (Barnett 2022; Kondo, Oosterwyk and Van Belle 2022; Suuriniemi 2023). Many South African SMEs lack the basic knowledge needed to understand the advantages and potential of CC (Jere and Ngidi 2020; Saratchandra and Shrestha 2022; Oosthuizen 2023). In South Africa, the adoption of ICT is a challenge due to lack of access to Internet infrastructure and unreliability of

Internet infrastructure, which limits the use of CC (Motema and Appiah 2019; Venter *et al.* 2019; Ravele and Mtotywa 2022). In addition, manufacturing SMEs in South Africa have limited financial resources, which makes the cost of CC services a barrier to their adoption (Jeza and Lekhanya 2022; Maphosa and Maphosa 2022). SMEs in South Africa often struggle to access support, advice and guidance to assist them in adopting CC (Svenson 2021; Van der Hoogen, Scholtz and Calitz 2021). The reluctance of SMEs in KZN to adopt cloud services has been attributed to the incompatibility of their existing IT systems with cloud solutions (Moyo and Loock 2021; Ciasullo *et al.* 2022).

South Africa has invested significantly in cloud infrastructure and services, and small business owners have begun to realise the benefits of moving to cloud-based systems (Mudzamba, van der Schyff and Renaud 2022; Hlongwane 2023; Pandey *et al.* 2023). The advantages offered by cloud-based services, including cost savings, increased flexibility for growth, and adaptability, have drawn SMEs in South Africa to investigate the possibility of adopting these services (Jeza and Lekhanya 2022; Moyo 2021; Ravele and Mtotywa 2022). In addition, the South African government has actively promoted the adoption of cloud technologies among SMEs through the provision of access to programmes such as the Innovation Fund that are aimed at supporting SMEs as they adopt cloud technology (Makoza 2023; Mhlongo *et al.* 2023; Signé 2023).

Despite the benefits offered by CC, South African SMEs have not fully adopted cloud services (Dyubele, Cele and Mbangata 2020; Mudzamba *et al.* 2022: 2; Shibambu 2022). This has been attributed to a lack of clarity and a limited understanding of cloud technology among SMEs in South Africa (Ruiters and Masigo 2021; Mkansi and Nsakanda 2023). Hence, there is a need for a framework to guide the adoption of ICT by manufacturing SMEs, which is the focus of this study. The framework proposed in this study will enable manufacturing SMEs to appreciate the numerous advantages of CC, such as the ability to rapidly and easily deploy complex solutions, access to rapid and expansive computing resources, and the ability to quickly and securely interact with customers, partners, and suppliers (Mosweu, Mosweu and Luthuli 2019; Moyo and Loock 2021).

A number of organisations in South Africa have begun to adopt cloud services in order to reap the benefits of fast deployment, scalability, and cost savings, which has led to increasing acceptance of CC among South African SMEs (Mulaudzi 2020; Dlamini 2022; Gwala and Mashau 2023). While a large number of SMEs in South Africa, especially those in urban areas, use the Internet and web-based and cloud-based services, a lack of Internet connectivity has been found to be particularly detrimental to SMEs in KZN in comparison to other provinces (Moyo and Looock 2021). This issue is prevalent in SMEs in developing countries, which are slow to adopt modern technologies and software that are compatible with business practices (Msomi, Ngibe and Nyide 2019: 6).

In order to identify the degree of preparedness and the capacity of South African firms to either commence or accelerate the use of local cloud provider services, a framework or model is required (Moonasar and Naicker 2020: 2). There is a dearth of research on the adoption of CC in the context of manufacturing SMEs in KZN, hence the need for this study, which focuses on developing a framework to guide the adoption and use of technology by SMEs.

2.6.4 Influence of ICT on competitiveness

Competitive advantage refers to providing greater value to customers through reduced product or service costs (Pickard-Whitehead 2018; Makaleng and Hove-Sibanda 2022). With the constant progression of innovation and changes in customer needs and expectations, criteria for competitive advantage also change (Sitharam and Hoque 2016: 278; Motjoloane and Ruhode 2022). The advent of ICT has revolutionised the way in which SMEs compete (Baporikar 2021; Khoza, Adeniyi and Ayandibu 2022). The advancement of technology has enabled manufacturing SMEs to leverage digital tools and platforms to compete with larger businesses in a variety of ways (Mtshali and Jili 2022; Etim and Daramola 2023). With ICT, SMEs can reach a wider market and increase their efficiency, allowing them to compete on a more level playing field with larger competitors (Nunden *et al.* 2022; Saruchera and Mpunzi 2023). ICT can also help SMEs become more competitive by allowing them to create more flexible relationships with business partners using speedier and more reliable communication channels (Pillay 2016: 23). ICT has opened up numerous methods of communication

and marketing, thus enabling manufacturing SMEs to promote their services to potential customers more easily and cost-effectively (Cele and Van Belle 2023; Maxwell 2021).

The likelihood of SMEs surviving is limited due to a variety of factors, one of which is a lack of innovative manufacturing and marketing practices (Prasanna *et al.* 2019: 4). Technology can help SMEs become more competitive by allowing them to create more flexible relationships with business partners using faster and more reliable communication channels (Pillay 2016: 23). With the constant advancement of technology, SMEs need to continuously update their marketing strategy to ensure that they remain competitive in a changing business environment (Sitharam and Hoque 2016: 278). Despite the aid provided by governments and other organisations, small businesses in developing nations struggle to grow, primarily because they lack the necessary technological expertise (Sitharam and Hoque 2016: 278). A study conducted by Maziriri (2020: 7) found that manufacturing SMEs have focused on increasing their competitive advantage through marketing. ICT adoption is another area on which manufacturing SMEs need to focus in order to address competitive challenges (Prasanna *et al.* 2019: 6). Inability to keep up with evolving consumer demands and technological progress results in the failure of SMEs to thrive amidst competition (Al Buraiki and Khan 2018: 3). Manufacturing SMEs need to be able to respond to these technological changes, and competence in the use of IT applications in their operations is one factor that contributes to their ability to do so (Salah, Yusof and Mohamed 2021).

2.7 Technological innovations for manufacturing SMEs

For SMEs seeking to thrive in a competitive manufacturing environment, implementing contemporary technologies has become crucial. Numerous cutting-edge technologies, including automation, CC, virtual reality (VR), and the Internet of Things (IoT), are transforming the manufacturing industry and providing SMEs with previously unheard-of chances to increase productivity, cut costs, and boost their competitiveness (Tan and Sidhu 2022). This section explores a wide range of technologies that are available to SMEs and illuminates how manufacturing SMEs can make use of these technologies to boost productivity, innovation, and long-term business success.

2.7.1 Cloud computing

The National Institute of Standards and Technology defines CC as “a model for enabling very convenient, on-demand network access to a shared pool of configurable computing resources such as networks, servers, storage, applications, and services, which can be rapidly provisioned and released with minimal management effort or service provider interaction” (NIST 2011: 2 cited in Wambugu and Ndiege 2018: 44). CC is a new paradigm that supports the utility computing model, in which computing resources are offered and used as a service on demand; this lowers barriers to access computing resources and increases the ease with which enterprises may employ technology (Govo *et al.* 2022; Walls 2022; Sultan 2023).

Shetty and Panda (2021: 7) identify three key motivating factors for SMEs to adopt CC: firstly, the usage-based model eliminates the need for investment in hardware, software, and support systems; secondly, CC provides IT resource flexibility and scalability; and thirdly, CC is a key factor in planning for business growth and resilience. CC is likely to be an attractive option for many manufacturing SMEs as it is cost-effective and enables easy access to IT services without having to pay for the IT infrastructure (Kiryakova, Angelova and Yordanova 2015: 392). In addition to flexibility, CC offers maximal use of resources without any costs being incurred for maintenance (Widyastuti and Irwansyah 2018). The adoption of CC also enables SMEs to offer services to their customers remotely, as CC is not bound to infrastructure (Statistics South Africa 2021; Bouey 2020: 10). As a business model, CC offers hosted services such as Nerd Support and Creatio over the Internet, which can assist SMEs with IT and customer experience (Annosi *et al.* 2023). According to Widyastuti and Irwansyah (2018), CC can reduce the need for SMEs to acquire software licenses by enabling them to use software via cloud services at a lower cost. This could assist them to overcome some of the challenges of compliance with government regulations.

CC has powered the technology evolution by offering cloud-based systems that facilitate effective data processing and is among the top five most influential emerging technologies (Vasiljeva, Shaikhulina and Kreslins 2017: 444). CC offers Software-as-a-Service, Infrastructure-as-a-Service, and Platform-as-a-Service benefits to businesses and governments, thereby providing infrastructure services, storage, content delivery, networking, API management, security, and migration tools (Sikeridis

et al. 2017: 2; Islam *et al.* 2023). A study conducted by Chen (2020) highlights the importance of the adoption of technologies such as CC and additive manufacturing in enabling manufacturing SMEs in the clothing and textile industry to meet customer demands and deliver products on time at the required quality (Chen 2020). CC is a key element in cloud-based manufacturing, which refers to the combination of various emerging technologies with new developments in the manufacturing process (Ryfors, Wallin and Truvé 2019: 11).

The adoption of technologies such as artificial intelligence (AI), robotics, and CC may result in unknown challenges for SMEs despite the availability of training to equip managers with the necessary skills (Stankovska, Josimovski and Edwards 2016: 218). Some SMEs are hesitant to use CC services because these services are handled by third parties, which makes maintaining privacy more difficult (Neicu *et al.* 2020: 4). A study conducted by Xu, David, and Kim (2018: 93) highlights the security risks of connecting everything to everything else in the IoT, which would necessitate the implementation of additional security measures. However, a study conducted by Shohaieb, Genedy, and Hammad (2015: 5) asserts that manufacturing SMEs cannot be innovative unless they take risks and are proactive. Palos-Sanchez, Arenas-Marquez and Aguayo-Camacho (2017: 1275) recommend using a cloud strategy that considers the maturity, benefits, and security of the technology. Security is critical in e-commerce environments because threats may impede the progress of the technology. The primary goal of information security is to preserve the confidentiality, integrity, and availability of data, regardless of its format (Hussein *et al.* 2019: 414).

2.7.2 Internet of Things

The 4IR is based on the establishment of smart factories that use IoT, cyber-physical systems, and CC to interface with the environment and control the manufacturing process (Agwa-Ejon and Pradhan 2018: 1). IoT is based on the notion of linking any device with an on/off switch to the Internet and possibly to other devices (Attaran 2017: 10). This technology is crucial in smart manufacturing as it automates procedures without requiring human intervention (Shai, Bakama and Sukdeo 2020: 2). IoT enables tangible objects to collect, process, and act upon data by connecting them to the Internet or to one another, and is therefore essential for overseeing and controlling

manufacturing operations in smart factories (Agwa-Ejon and Pradhan 2018: 3). IoT emerged as a combination of wireless, microelectromechanical systems, microservices, and the Internet; the merging of these technologies has aided in overcoming barriers between operational technology and IT (Attaran 2017: 12). IoT enables the control of manufacturing in real time by combining physical, digital, and biological data (Mhlongo *et al.* 2023).

According to Chapman (2021: 43), there is evidence that SMEs in KZN have access to three technologies that have been observed to operate effectively together: big data, IoT, and AI. In order to incorporate these technologies, SMEs in KZN need to adjust their strategic focus to begin engaging with these innovations (Chapman 2021: 43). However, it is evident that SMEs in South Africa are hesitant to use these technologies to their full potential (Mhlongo *et al.* 2023). The findings of the above-mentioned studies suggest that SMEs in KZN are not effectively utilising IoT technologies for purposes other than traditional marketing and communication. Strategic planning has been emphasised as being vital for these manufacturing SMEs to reap the immense benefits of IoT (Chapman 2021: 43; Garatsa and Dlamini 2021; Khoza, Adeniyi and Ayandibu 2022).

IoT has a wide range of applications, such as tracking and managing assets digitally (Odhiambo and Mwashita 2022; Yadav *et al.* 2023). With its cost and scalability advantages, IoT can be used by manufacturing SMEs to automate their production processes and make them more efficient (Tan and Sidhu 2022; Khan *et al.* 2022). By connecting machines, systems, and sensors, manufacturing SMEs can track inventory in real time, collect data for analysis, and cut costs associated with manual labour (Hamilton 2021). Automated processes can provide enhanced customer experiences by delivering personalised services and reducing the complexity of customer service (Nwachukwu and Affen 2023). The adoption of IoT technologies can benefit manufacturing SMEs significantly by enabling them to adapt to new developments and stay ahead of competitors (Noor 2022; Amini and Jahanbakhsh Javid 2023).

2.7.3 Smart manufacturing

4IR technologies are expected to drastically alter SMEs' manufacturing processes and resource allocation by allowing them to create and deliver downstream services (Futcher and Sunjka 2018: 1). A study conducted by Maisiri and van Dyk (2021: 2) found that although an increasing number of studies had focused on 4IR technology adoption drivers and impediments in many developed and developing countries, none had yet been conducted in South Africa.

Smart manufacturing has been identified as one of the most promising opportunities for manufacturing SMEs (Mkhize 2022; Mboniyane *et al.* 2023). Smart manufacturing offers improved reliability and product quality, improved efficiency, increased throughput, and improved agility in product release cycles (Mncwango 2022; Mhlongo *et al.* 2023). According to Martinsuo and Luomaranta (2018), smart manufacturing technologies enable failure detection; if a machine fails to function properly, the controlling system can quickly identify the issue and report it for maintenance. Studies conducted by Mofolasayo *et al.* (2022) and by Nwachukwu and Affen (2023) found that by leveraging smart technologies, manufacturing SMEs could improve productivity, cost management, and customer experience.

In addition to ensuring that they remain competitive, manufacturing SMEs will need to address a number of challenges with regard to 4IR implementation, including a lack of availability of funding, user-friendliness, safekeeping of data, controllability issues, failures resulting from changes in the integration of technology, unskilled employees, and lack of standards and regulations (Agwa-Ejon and Pradhan 2018: 1). Once these challenges are addressed, manufacturing SMEs will be able to reap the benefits of the adoption of 4IR technologies.

The current business environment necessitates the urgent attention of SMEs to technology adoption (Gumbi and Twinomurizi 2020: 1). According to Ntuli (2022), the level of computer literacy among SME owners in KZN is minimal, as is the level of adoption of modern technologies to boost the effectiveness of company processes. The results of a study conducted by Ngibe and Lekhanya (2020) indicate that manufacturing SMEs in KZN prefer to use less modern technology, which puts

pressure on the production process and consequently makes SMEs economically unviable in comparison to larger enterprises. Inadequate utilisation of ICT in South African manufacturing industries is a major concern in that it obstructs the country's progress towards smart manufacturing practices as well as the country's efforts to compete globally (Rasheed 2022). Because manufacturing SMEs are underfunded, the significant expenses associated with the implementation of smart manufacturing are its main detractor (Shai *et al.* 2020: 2).

The Department of Trade and Industry has identified key intervention areas to support the development of smart factory operations in KZN (Ntuli 2022; Mhlongo and Daya 2023). These intervention areas include developing capacity building initiatives, supporting SMEs in the acquisition and implementation of smart factory technologies, and incentivising research and development to spur the development and adoption of modern technologies (Molina *et al.* 2021; Sharma, Joshi *et al.* 2023). The KZN Industrial Technology Assistance Project has been instrumental in facilitating capacity building programs for SME owners and employees (Ntuli 2022; Dladla and Mutambara 2022). These initiatives have included seminars and mentorship strategies that are designed to enhance leadership, technical, and entrepreneurial competencies (Ncube 2022; Sheik 2023).

2.7.4 Artificial intelligence

The adoption of AI enables manufacturing SMEs to utilise predictive analytics, in which systems analyse substantial amounts of data and are capable of making proactive and intelligent judgments to tackle complicated manufacturing-related challenges (Rao 2017: 19). In practice, this means collaborating with machines to improve work processes, increase efficiencies, and spur economic growth (Schoeman and Schall 2019). For South African manufacturing SMEs, the adoption of AI can help improve operations by reducing errors, improving quality and delivery, and, in some cases, completing jobs that are beyond human capabilities (Nunden *et al.* 2022). A study by Kumar and Ayedee (2021: 5) found that around 80% of everyday tasks, such as determining client needs and maintaining a positive relationship resulting in increased sales productivity, can be enhanced by the use of AI. Together with other 4IR

technologies, AI and the digitisation of work processes can enable employees of manufacturing SMEs to work remotely (Huang 2023).

However, Schoeman and Schall (2019) argue that South Africans, like many other people around the world, are fearful that AI will eliminate their employment and exacerbate wealth inequality. This technological anxiety is further exacerbated by the fact that intelligent automation enables self-learning machines and software to identify and close gaps in their knowledge (Kamal *et al.* 2020). The manufacturing industry in South Africa is currently characterised by a considerable proportion of unskilled and semi-skilled workers, which has delayed the adoption of AI (Maisiri and van Dyk 2021: 1). People are at the heart of technological change, and their willingness and preparedness to embrace digital transformation are critical to its success (Maisiri and van Dyk 2021: 3). Etim (2021) suggest that as SMEs in KZN progress towards the adoption of e-commerce, they should strive to progressively increase their adoption of ICTs such as e-mail, the Internet, a website, a computerised database of customers, a computerised database of suppliers, and a computerised inventory of products and services.

With its capacity to process extensive manufacturing information, AI has the potential to aid small businesses in identifying issues, slowdowns, and potential areas for improvement (Nwachukwu and Affen 2023). AI does this by alerting organisations to production errors ahead of time and recommending actions to fix the issues (Fonseka *et al.* 2022). This enhances efficiency, minimises wastage, and promotes the achievement of organisational objectives. AI-powered predictive maintenance systems use advanced technology to watch over machines and equipment in real time (Bharadiya 2023). This assists in preventing costly problems and reducing the amount of time lost, ultimately enhancing the efficiency of the equipment (Chapman 2021: 43). AI can continuously monitor and control costs across various aspects of the business from procurement to production, which can help manufacturing SMEs maintain profitability in changing market conditions (Singh and Gurtu 2022). In addition, manufacturing SMEs can use AI to optimise their inventory by accurately estimating the demand for specific products and regulating their stock levels accordingly (Javaid *et al.* 2022).

2.7.5 Virtual reality

VR is a technology that enables users to engage with a three-dimensional computerised environment that simulates real-world objects and events (Van Wyk 2022). While the digitalisation of industrial production, often known as “Industry 4.0”, “Industrial Internet”, or “Digital Factory”, enables more flexible and efficient manufacturing, the complexity of this approach requires such systems to be designed in such a way that users can easily interact with them (Büttner, Sand and Röcker 2017: 433).

Almost all manufacturing positions in South Africa, regardless of sub-sector, require employees to learn through hands-on experience, often with hazardous or expensive machinery. To address this concern, IQbusiness (2018: 24) recommends virtual training, which reduces the risk and cost of training manufacturing workers using real machinery while also avoiding the time-consuming and expensive process of purchasing machinery for training purposes.

Additionally, VR and augmented reality (AR) have the potential to enable manufacturing employees to work from home; one of the most powerful features of these technologies is the ability to make people who are physically separated feel as if they are in the same room (Hořejší, Novikov and Šimon 2020). This has been especially relevant since the start of the global COVID-19 pandemic, during which this study was conducted.

The use of VR technology in manufacturing presents a potent tool for developing, testing, and optimising different environments and procedures in a virtual environment before producing a costly physical prototype, resulting in enhanced productivity and effectiveness in manufacturing techniques (Liagkou and Stylios 2019: 451). Many sectors have used VR to help design, develop, and assess new concepts, but limited research has been conducted on the adoption of VR by manufacturing SMEs (Berg and Vance 2017: 3). As noted by IQbusiness (2018: 24), manufacturing SMEs must keep track of key trends in developing technology, such as VR, in order to become more dynamic and responsive. VR has been identified as having great potential as a maintenance tool that can be used by SMEs to train users in product maintenance; it

can also enable live support to be provided in the event of product failure (Fussell and Truong 2022).

In South Africa, VR and AR are still in their preliminary stages of adoption in SMEs in Durban (Ntuli 2022). A study conducted by Jeza (2021) found that SME owners in KZN frequently lacked knowledge of the appropriate IT applications to make e-commerce more enticing and applicable to their enterprises.

The adoption of VR by manufacturing SMEs can save training costs by means of training simulations that train workers in a secure and supervised setting (Njomane and Telukdarie 2022). In addition to ensuring that trainees are protected from hazardous tasks, such training can also assist SME managers to reduce the chances of accidents and errors in production (Afolabi, Nnaji and Okoro 2022). AR enables employees to be given step-by-step instructions as they work, without requiring them to touch or hold a device (Majil, Yang and Yang 2022). Product visualisation aids with AR technology can be used to preview the appearance of products in reality prior to production (Hoffmann *et al.* 2023). Additionally, manufacturing SMEs can use AR technology to allow their customers to personalise products in real time, which improves customer experience (Nhuvira and Dorasamy 2021).

The results of this study confirm that VR has the potential to support manufacturing SMEs in enhancing their products to align more closely with market preferences. Woodenways, an established manufacturing SME in KZN that participated in this study, has leveraged VR technology skilfully in the manufacturing of hardwood furniture.

2.7.6 Green innovation and manufacturing

In South Africa, manufacturing contributes significantly to hazardous emissions, environmental waste, resource depletion, polymerised compound emissions, and landfill combustion (Alhassan and Scholtz 2019: 32). Business operations are evolving as a result of the requirement for sustainable practices (Rasheed 2022). As the general public becomes more aware of environmental challenges, businesses are

increasingly incorporating environmental considerations into their operations (Setyaningsih *et al.* 2019: 585).

The concept of Green IT involves implementing strategies to safeguard the environment against the negative impacts associated with the production, usage, and disposal of IT equipment and infrastructure (Baggia *et al.* 2019: 1). “Green” refers to environmentally friendly technologies or processes that have a lower negative impact on the natural environment than conventional ones (Vrchota, Pech, Rolinek and Bednář 2020). Green innovations are new environmental strategies, ideas, goods, processes, or services aimed at reducing the negative environmental effects of business activities (Ruslan, Senin and Soehod 2014: 60). Determinants of the likelihood of adoption of green innovations include ease of use, ease of integration and compatibility of the innovation (Bugwandin 2022).

Green SMEs employ eco-friendly practices and materials, either in their manufacturing processes or in their service provision (Dissanayake, Tilt and Qian 2019: 5). Green manufacturing, which refers to manufacturing methods that reduce pollution and waste, is one of the solutions used by businesses to address environmental issues; green manufacturing strategies comprise product design and engineering initiatives aimed at reducing environmental effects (Setyaningsih *et al.* 2019: 585). The adoption of green manufacturing promotes and strengthens organisational capabilities for green product and process innovations, which can lead to long-term organisational benefits (Awan, Arnold and Gölgeci 2021). For a collaborative green manufacturing system to be established, it is vital to make environmental sustainability an integral part of the firm’s strategy, incorporate eco-friendly actions throughout the entire business process, and effectively communicate and promote the benefits of these actions to all stakeholders (Dissanayake *et al.* 2019: 6).

While there is a dearth of research on the impact of green marketing techniques on the strategic advantage and business performance of South African manufacturing SMEs, many manufacturers in South Africa have embraced the concept of “going green” and have incorporated green marketing into their operations (Maziriri 2020: 3). The findings of studies conducted by Maziriri (2020), Mukonza (2020), and Aliamutu (2022) indicate that there is a growing trend of the adoption of green manufacturing

by SMEs. However, the findings of this study seem to contradict this indication, as evidenced by concerns regarding the consumption of energy and wastage of raw materials in the manufacturing operations at Unilever's Indonsa factory in Durban. A study conducted by Mahohoma (2020) highlights the importance of creating, purchasing, and using materials and products that limit the amount and toxicity of waste through source reduction.

South Africa is actively engaged in implementing the NDP's significant measures aimed at addressing and mitigating the consequences of climate change by 2030 (Maphiri *et al.* 2021). The use of environmentally friendly manufacturing techniques will not only benefit manufacturing SMEs but will also contribute towards achieving the NDP's goals (Maziriri *et al.* 2022). The adoption of green manufacturing practices will help manufacturing SMEs reduce the costs of energy and daily operations (Mamba, Eboule and Pretorius 2022). Even though manufacturing SMEs may have to allocate funds initially to implement green initiatives, these initiatives can provide cost savings and competitive advantage (Bhebhe *et al.* 2023). Banks and investors have shown a preference for supporting environmentally conscious businesses (Mukonza 2020). The adoption of eco-friendly manufacturing methods may enhance access to funding and investment opportunities for SMEs that struggle financially (Deacon and Botha 2022).

2.8 Conclusion

This chapter has presented a comprehensive assessment of past studies which have provided insight into the background of SMEs and their vital contribution to economic improvement in a global context, the development of SMEs in South Africa, and the effects of technological barriers on the performance of SMEs. It has drawn on the perspectives of various studies of the adoption of emerging technologies by SMEs in both developing and developed countries, with an emphasis on South African SMEs based in KZN. In addition, it has highlighted the attention that the adoption of 4IR technology has attracted throughout the world and its progressive influence on a variety of business activities.

Like many other developing countries, South Africa has experienced a high SME failure rate. This has been attributed to several factors, including SMEs' unwillingness to introduce 4IR technologies. In addition, South African creditworthiness was repeatedly downgraded due to the civil unrest that occurred in July 2021 and the economic impact of the COVID-19 pandemic, which further exacerbated the problems faced by the already ailing SME sector.

Previous studies have found that SMEs in KZN appear to use the Internet mostly to communicate with suppliers via email, and in some cases also for marketing purposes. The reluctance of manufacturing SMEs to adopt 4IR technologies has negatively impacted their ability to transform traditional manufacturing methods into a smart manufacturing approach. Manufacturing SMEs in KZN have been found to struggle with growth and long-term economic competitiveness, both of which can be improved through innovation. These findings indicate a need for the development of manufacturing strategies, which are an almost undeveloped resource. For SMEs that are new adopters of technology, the technological and organisational environment, perceptions regarding the use of technology, and the ease of use of technology are major factors influencing technology adoption. Manufacturing SMEs will need to invest heavily in advanced technology to ensure their viability. This necessitates the strategic use of revenue to pursue technological advancements that will strengthen business processes and operations.

The studies reviewed in this chapter have shown that the adoption of new technologies has the potential to enhance the efficiency of SMEs, to reduce their operational costs, and to increase the success of their marketing strategies, both locally and globally. The literature review has also highlighted the challenges experienced by SMEs in the adoption of technology, including a poor economy, a lack of education, a lack of funding, a lack of infrastructure, and a lack of awareness of existing technologies available to SMEs. Further impediments to technology adoption include cybersecurity, fraud, and privacy concerns, as well as a lack of technical understanding, limited interoperability, and limited data manageability.

This chapter has identified important criteria for successful application of this study's proposed framework for technology adoption by manufacturing SMEs. While the

adoption of 4IR technologies poses many challenges to SMEs, the benefits are far greater. These include improved business agility, improved innovative approaches, automation, and self-optimisation enabled by smart manufacturing, which increases efficiency and has the potential to greatly decrease manufacturing errors and downtime.

CHAPTER THREE

THEORETICAL FRAMEWORK

3.1 Theories considered for this study

A model is a theoretical foundation for examination of information and elucidation of the meaning embedded in the data of a study (Kivunja 2018: 44). It is a structure that reviews perceptions and philosophies that have been established from information that has been verified and disseminated in the past to help synthesise a theoretical understanding of the world (Laato *et al.* 2020). A theory is a collection of interrelated assertions indicating discoveries that can subsequently be tested for the aim of describing or predicting (Thomas 2020). It is based on a comprehensive organisation of knowledge that can be used to find solutions to problems (Thomas 2023). For a set of arguments to constitute a theory, it must offer testable evidence, validation, predictions applicable across contexts, and explanatory principles clarifying phenomena and their causes (Rasenberg, Özyürek and Dingemanse 2020).

This study uses a conceptual framework that is derived principally from the TAM, which was mentioned in Section 2.6.1, and the technology-organisation-environment (TOE) theoretical framework. An overview of these and other relevant theories that influence the foundation of this study are given in this chapter.

3.1.1 Technology acceptance model

The TAM, which was developed by Davis (1985), is a well-accepted theory that describes how firms come to embrace and employ new technologies. The widespread adoption of the TAM has been attributed to its good theoretical assumptions and practical efficiency (Mugo *et al.* 2017: 2; Lamola 2022: 3). The TAM has been modified and expanded by scholars such as Cimperman, Brenčič and Trkman (2016: 24), Rajak and Shaw (2021: 2), Fussell and Truong (2022), and Kamal, Shafiq and Kakria (2020: 4), who have added elements such as technological anxiety, perceived risk, reluctance to use technology, and privacy, all of which may influence the adoption of an innovation. The TAM's major goal is to predict factors associated with the decision to

adopt new technologies (Martín-García, Redolat and Pinazo-Hernandis 2022). However, it is challenging to assess practices because behaviour is often encouraged by concealed dispositions (Muranganwa 2023). The behavioural intentions that influence technology acceptance by manufacturing SMEs are the perceived usefulness of the technology, its ease of use, and goals and beliefs with regard to the technology (Lanlan, Ahmi and Popoola 2019; Qader *et al.* 2022: 15). Successful implementation of technology adoption is closely linked with the user's willingness to accept the innovation (Masood and Sonntag 2020; Faqih 2022).

There are several challenges associated with the use of the TAM, particularly in manufacturing SMEs. Studies conducted by Masood and Sonntag (2020: 7) and Nazir and Khan (2022: 4) found that SMEs in the manufacturing industry had limited knowledge and understanding of new technologies, which made it difficult for them to use the TAM framework effectively. In addition, a lack of adequate training and support when adopting new technologies has been found to lead to issues with the implementation and usage of these technologies in manufacturing SMEs (Kiran and Reddy 2019: 275; Sharma, Sehrawat *et al.* 2021: 1815). Manufacturing SMEs have limited financial resources and expertise to invest in technology adoption, which makes it challenging to implement the necessary changes (Naidoo 2022: 290; Nazir and Khan 2022: 2; Mhlongo and Daya 2023: 1). Studies conducted by Kamal *et al.* (2020: 4) and Mkhwanazi (2023) found that manufacturing SMEs hesitated to invest in new technologies due to cost and privacy concerns and uncertainty regarding the potential benefits. In addition, new technologies may not always be scalable for SMEs in the manufacturing industry, particularly if they have limited resources or lack infrastructure (Machado *et al.* 2021; Zamani 2022). Fears of complexity and having to alter current procedures in order to integrate new technologies into existing systems can exacerbate reluctance to adopt new technologies (Peillon and Dubruc 2019: 148).

On the other hand, Smit *et al.* (2022); Singh and Chan (2022) argue that when used correctly, the TAM can provide manufacturers with the insights they need to understand and influence the technology adoption process. Hamid, Frank and Moore (2016: 646) and Hasani, Rezania *et al.* (2023) claim that the perceived usefulness of new technologies is dependent on the degree to which an organisation believes that the adoption of the technologies will positively influence its performance. By

understanding the factors that influence technology acceptance, manufacturing SMEs can better assess the potential benefits of adopting new technologies and make informed decisions about technology investments (Nazir and Khan 2022; Sukanthan Rajendra *et al.* 2022; Bhatia and Diaz-Elsayed 2023). In addition, manufacturing SMEs should be able to identify areas where user experience can be improved by making changes to a system's user interface or making the system easier to use (Krause *et al.* 2023; Chopra *et al.* 2022). Training and support programs can be tailored to address such issues (Baloyi and Khanyile 2022). By doing so, manufacturing SMEs can improve the efficacy of their technological solutions, thereby increasing efficiency and productivity (Singh and Gurtu 2022).

According to Lateef and Keikhosrokiani (2023) and Kruger and Steyn (2023), the perceived ease of use (PEOU) of a technology in an organisation is influenced by the organisation's ability to identify opportunities for growth and innovation as well as its ability to effectively manage its production operations. These abilities depend on the organisation possessing the technical ability and expertise necessary to stay current with market developments (Mkhize 2022; Ntuli 2022). While Nguyen *et al.* (2022) claim that PEOU is independent of educational levels and has no direct bearing on how well an organisation's operations function, Roopchund (2023) asserts that an enhanced understanding of the sector can assist manufacturing SMEs to increase the efficacy and effectiveness of their operations and the PEOU of technologies. For manufacturing SMEs, improving PEOU is largely dependent on the availability of resources such as access to capital, technology and skilled personnel (Kumar Bhardwaj, Garg and Gajpal 2021). Manufacturing SMEs should also pay close attention to environmental constraints such as organisational structure, user characteristics, and system design features (Lanlan, Ahmi and Popoola 2019: 325; Nikou, De Reuver and Mahboob Kanafi 2022; Howard *et al.* 2023). In addition, maturity and education levels are important factors that may encourage reception of technologies and readiness to implement them; however, the TAM does not take these factors into account (Jeza 2021).

3.1.2 Technology-organisation-environment framework

Tornatzky and Fleischer's (1990) TOE paradigm was established with a focus on examining the factors contributing to successful technological advancements in companies (Matikiti, Mpinganjira and Roberts-Lombard 2018: 3). The primary objective of the TOE framework is to inform technology adoption decisions by considering the interplay between the features of the technology, the organisational environment in which it will be implemented, and the external environment, which includes legal and regulatory frameworks, competition, and access to resources (Tornatzky and Fleisher 1990 cited in Ghobakhloo *et al.* 2022: 1031; Pooe, Masakale and Munyanyi 2022; Chingapi and Steyn 2022).

The TOE theoretical framework highlights the organisational context of the acceptance and implementation of 4IR technologies; studies conducted by Alkhalil, Sahandi and John (2017: 4) and Amini and Jahanbakhsh Javid (2023) have shown that technology adoption can be restricted or enabled by the structure and operations within a firm. The external commercial setting is also an important factor to consider because the characteristics of the manufacturing sector, including competitiveness, technological advancements, and market conditions, can influence the adoption of the TOE framework (Gui *et al.* 2020; Katebi, Homami and Najmeddin 2022: 4; Rafiquea *et al.* 2022; Amini and Jahanbakhsh Javid 2023). If the sector is highly dynamic and innovation-driven, there may be a greater need to adopt the framework to stay ahead of the competition (Teece 2023). By enhancing understanding of how all the above-mentioned factors interact to affect the environment in which the technologies will be implemented, the TOE framework enables manufacturing SMEs to assess which technologies would be likely to be successfully adopted (Lutfi 2022; Maroufkhani, Iranmanesh and Ghobakhloo 2023).

The TOE framework has been used for technology adoption in a variety of innovative, commercial, and ideological situations (Jahanbakhsh Javid and Amini 2023), and has proved to be helpful in examining a variety of innovations and situations (Ntuli 2022). The extent to which the adoption of new technologies is possible is affected by the existing technologies within an organisation (Jere and Ngidi 2020: 3). While TOE-based frameworks have been used for assessing organisational readiness prior to

technology adoption and have been recommended and authenticated for usage in large firms, key elements and alternative frameworks which might offer guidance for innovation integration in SMEs are still a subject of interest (Jeza 2021). In this study, the TOE framework is integrated with the TAM due to the link between a manufacturer's intention to use a technology and the technological, organisational, and environmental context (Thaha et al. 2022). SMEs seeking to gain the benefits of ICT adoption through lucrative business operations must analyse both their internal and external environments, including product and service offerings, production processes, supply, and markets, as well as their organisational skills (Kankisingi and Dhliwayo 2022).

However, Bryan and Zuva (2021: 141) and Van Zyl (2022) caution manufacturing SMEs against the use of the TOE model, noting that SMEs lack technological resources and that the TOE model cannot explain adoption variance. Furthermore, technological resources alone are insufficient for successful technology adoption; other essential factors include technological readiness, change management, security issues, and the potential to capitalise on technological investment through various avenues (Bryan and Zuva 2021: 141; Ndlela 2022; Dora *et al.* 2022). Therefore, even though the TOE model is an appropriate model for analysing technical advancements in the face of uncertainty surrounding their adoption, depending only on a TOE-based framework to guide technology adoption is not sufficient (Nandi *et al.* 2021; Ullah *et al.* 2021).

3.1.3 Dynamic capability theory

The dynamic capability theory (DCT) was developed by Teece and Pisano (1994). The dynamic capabilities of a firm refer to its capacity to innovate, respond to change, and bring about change that benefits customers (Teece, Peteraf and Leih 2016; Liboni *et al.* 2022). For manufacturing SMEs, dynamic capabilities can be viewed as an answer to the need for change or new opportunities in the context of competition (Rashidirad and Salimian 2020; Liboni *et al.* 2022). The DCT emerged as a response to the resource-based view (RBV), which asserts that in order to preserve their competitive advantage, manufacturers should assess their ability to invest in their internal technological capabilities instead of relying exclusively on outsourced ICT skills

(Mweru and Maina 2016: 215; Mataruka 2022). The DCT evolved as a reaction to the limitations of the RBV, specifically with regard to interpreting the development and updating of resources and capabilities in accordance with continuously changing environments (Bleady, Ali Hasaballah and Ibrahim 2018). The DCT can enable manufacturing SMEs to recognise changes in the market, including customer preferences, regulatory changes, competitive developments, economic trends, and advancements in technology (Mofokeng 2022; Nguyu 2022). In order to distinguish themselves from their competitors, manufacturing SMEs must continuously assess their current capabilities and develop new technologies, skills, and processes (Jeza 2022; Ismail 2022). The DCT implies that manufacturing SMEs should use capacity development and radical transformation strategies to identify and develop new competencies that will enable them to stay competitive (Ferreira, Coelho and Moutinho 2020; Khan, Daddi and Iraldo 2020). The development of ICT strategies and initiatives can assist manufacturing SMEs to remain competitive and to foster an innovative atmosphere within their organisations (Marx and Levy 2022; Burger 2022; Shatila and Jalloul 2022; Msimango 2023).

While the DCT provides a valuable framework for understanding how organisations can adapt and innovate in a changing environment, it also has limitations when applied to manufacturing SMEs (Singh, Charan, and Chattopadhyay 2022; Pooe, Masakale and Munyanyi 2022; Mantje, Rambe and Ndfirepi 2023). Manufacturing SMEs often have limited resources, both in terms of financial capital and human resources (Kotane 2022; Mkhize 2022). The DCT emphasises the need for continuous investment in resources to develop and maintain capabilities (Singh, Charan and Chattopadhyay 2022; Khurana, Dutta and Ghura 2022). However, resource constraints limit the ability of manufacturing SMEs to invest in developing and deploying dynamic capabilities (Larrea 2022; Moreira, Navaia and Ribau 2022). The DCT suggests that organisations should have formalised processes for identifying, obtaining, and reconfiguring resources (Cristofaro and Lovallo 2022). However, manufacturing SMEs often operate in an informal and entrepreneurial manner with less emphasis on formalised processes and routines, which hinders their ability to systematically develop and deploy dynamic capabilities (Zwane and Zhou 2023; Maduku and Zerihun 2022; Strydom, Kempen and Tselepis 2023). To address this, SMEs in the manufacturing

sector can enhance their growth and sustainability through government programmes that provide free training initiatives to develop new skills (Akoh and Lekhanya 2022).

ICT adoption may not be a major challenge for large firms with adequate personnel and financial resources, but it is often a challenge for SMEs with limited resources (Hlatywayo 2022; Mtshali and Jili 2022). Manufacturing SMEs that lack dynamic competencies fail to maintain a competitive edge, especially in an ever-changing business setting (Bari, Chimhundu and Chan 2022; Mansouri *et al.* 2022). As large firms form and competitors adapt and collaborate, old industry boundaries and conceptions of positioning become meaningless, which highlights the importance of dynamic capabilities (Wade, Meath and Griffiths 2022; Robson, Ojiako and Maguire 2022). In such a scenario, the challenge is to develop a unique dynamic capability that outperforms all others. Dynamic capabilities enable SMEs to differentiate themselves from their competitors by improving, changing, and revamping their business processes (Osterrieder 2023; Sahebalzamani 2023). However, the pursuit of dynamic capabilities will not enable a firm to do everything at once; each organisation has limited options as to what it can and cannot accomplish (Tabane 2022; Robson *et al.* 2022). A study conducted by Ferreira *et al.* (2020) found that developing dynamic capabilities does not always lead to better performance as the context in which such capabilities are employed has an impact on performance. Studies have identified an interrelationship between the TAM and DCT in that an organisation's decision to accept or reject technology is guided by the capabilities of the organisation as well as environmental, organisational, and governmental factors (Afolayan and de la Harpe 2020: 698; Katebi *et al.* 2022; Molina and Rajagopal 2023).

3.1.4 Diffusion of innovations

Rogers' diffusion of innovations (DOI) theory, which was developed in 1962, focuses on an innovation's technological attributes and users' perceptions of the innovation (Rogers 2003; Amini and Jahanbakhsh Javid 2023). The DOI theory has been widely used to evaluate technological preparedness and to identify factors impacting innovation in South African SMEs in a variety of sectors and industries, including the informal sector, the apparel sector, communication, and agriculture (Etim and Daramola 2023: 3; Nhuvira 2021: 5; Makuwe 2021: 40; Lose and Kapondoro 2020:

8274). However, there is a dearth of research on the use of DOI theory to guide technology adoption by manufacturing SMEs (Gumbi and Twinomurinzi 2020: 39). According to the DOI theory, decisions to adopt innovations are not made abruptly but result from thorough review processes; such processes take into account the conditions under which an organisation is likely to decide to adopt innovations (Rogers 1995; Carreiro and Oliveira 2019; Buruca 2023; Saad, Dulaimi and Zulu 2023). Therefore, manufacturing SMEs should take note that the qualities of an innovation play a major role in determining the rate of its diffusion (Ogwu 2021: 19; Makanyeza *et al.* 2023).

In addition to the factors discussed in Section 3.1.3 that guide a manufacturing SME’s decision to accept or reject technology, the DOI theory calls for an understanding of the role of the innovation-decision process in technology adoption (Pozo, Akabane and Tachizava 2019; Matsepe and van der Lingen 2022; Harrison and Pooe 2022). Figure 3.1 below illustrates the five stages in the innovation decision process: knowledge of the innovation, persuasion of the innovation’s value, decision to accept the innovation, implementation of the innovation, and confirmation of the adoption decision (Scott and McGuire 2017: 121; Cataldo *et al.* 2018).

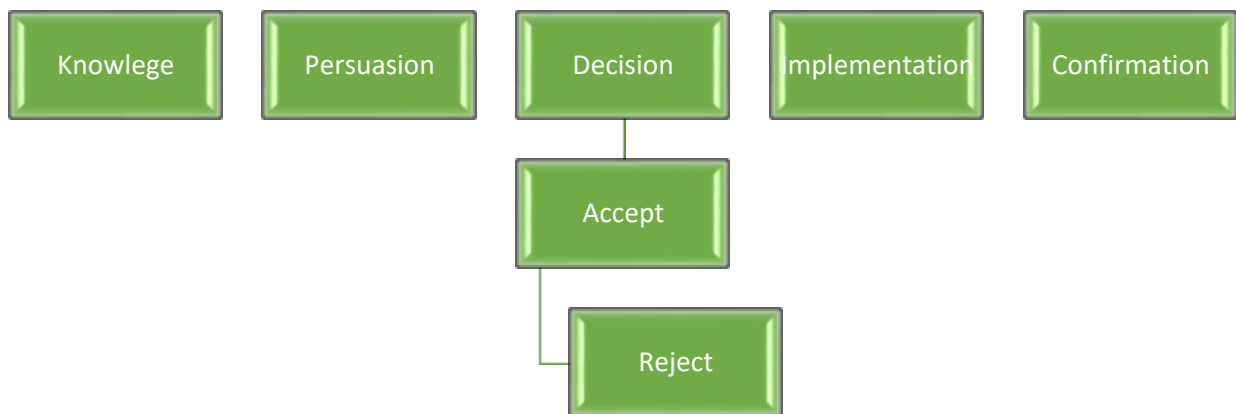


Figure 3.1: Innovation decision process (Rogers 2003)

3.1.4.1 Knowledge

A manufacturing SME’s decision to adopt a new technology can be greatly influenced by the knowledge it possesses about that technology (Zayed *et al.* 2022; Mboniyane

et al. 2023). It is crucial that decision-makers in manufacturing SMEs understand the potential benefits and risks posed by the technology to their firms, such as disruptions to operations, security breaches, and slower performance due to lack of expertise (Msomi, Olarewaju and Ngcobo 2021; Moloji *et al.* 2022; Yeap and Liow 2023). Taking all of these factors into account assists manufacturing SMEs to determine the best innovation investment decision and implementation strategy (Nazir and Khan 2022; Gupta, Fernandez-Crehuet and Gupta 2022). Knowledge of innovations can aid manufacturing SMEs in developing technology plans and short-term goals that are tailored to their particular needs (Mofokeng 2022; Msomi and Maharaj 2022; Bugwandin 2022). While manufacturing SMEs may possess the capacity to rapidly embrace new technologies, their capacity to do so effectively depends greatly on their familiarity with the technologies they intend to deploy (Jere and Ngidi 2020; Ghobakhloo *et al.* 2022). Manufacturing SMEs that are knowledgeable about the latest technologies and how these technologies can be utilised to enhance their manufacturing processes are more likely to easily identify the most effective solutions (Puliga and Ponta 2022; Agyei-Boapeah, Evans and Nisar 2022). In addition, remaining informed about the latest technological advancements and innovations enables smoother and more effective implementation of new technologies (Naidoo 2022; Singh, Anvikar and Sinha 2022; Oliveira *et al.* 2022; Nakasolya 2022).

3.1.4.2 Persuasion

Persuasion to adopt an innovation is logical only when the decision maker is aware of the innovation (Nunden 2020; Siyaya 2021). It is easier to persuade a manufacturing SME to accept a new technology if the owner possesses relevant knowledge (Mkhize 2022; Achola 2022). In a competitive manufacturing environment, persuading manufacturing SMEs to adopt technology is challenging because manufacturing SMEs are forced to constantly adapt, renew, reconfigure, and recreate their resources and capabilities (Kademete and Twinomurinzi 2019: 1; Harper and Pal 2022). An SME's decision to accept or reject a new technology is influenced by the technology's ability to simplify manufacturing activities and its ability to complement the firm's existing technology (Ngibe 2020b; Khuzwayo 2023). Manufacturing SMEs are more likely to be persuaded to adopt a technology if it will help improve efficiency, reduce costs, provide access to new markets, or improve customer service (Baloyi and

Khanyile 2022; Matsepe and van der Lingen 2022; Leso, Cortimiglia and Ghezzi 2023).

Manufacturing SMEs are often confronted with the reality of being less capable of adjusting to technological advances than larger organisations (Saruchera and Mpunzi 2023; Nkosana 2022; Ramugondo and Ocholla 2022). This has been attributed to a lack of resources, including access to finance, expertise, awareness of changes in the industry, and labour, as well as a reluctance to take risks using new strategies (Ndlela 2022; Madonono and Barnard 2020). In order to be proactive rather than reactive, manufacturing SMEs must be aware of the need to prepare for the future and consider a variety of strategies for future success (Ali *et al.* 2021; Zighan and Ruel 2023). In addition, investing in technological education may assist manufacturing SMEs to promote an innovative culture (Sharma, Raut *et al.* 2023; Ahimbisibwe *et al.* 2023).

3.1.4.3 Decision

Innovation adoption decisions are often driven by an organisation's need to accomplish certain goals or solve specific problems (Kraft, Lindeque and Peter 2022; Soni *et al.* 2022). The cost of technology acquisition, which includes the initial acquisition expenses as well as future maintenance and upgrade costs, is also a determining factor (Nazir and Khan 2022; Amini and Jahanbakhsh Javid 2023). While Gartner, Fink and Maresch (2022) and Nazir and Khan (2022) assert that the ease of use of a technology significantly influences a decision to embrace the technology, Raddats, Naik and Bigdeli (2022) and Krause *et al.* (2023) argue that ease of use is not a critical factor in technology adoption decisions because vendors that offer technical support services can help troubleshoot any issues that may arise. Thus, manufacturing SMEs must assess whether the benefits of a technology will outweigh the cost and effort required to integrate it into their systems before deciding whether to implement it (Sithebe 2022; Bugwandin 2022; Mofokeng 2022).

3.1.4.4 Implementation

Innovation strategies can be planned and implemented with regard to products, processes, the organisation, marketing, or a combination of these (Mallinguh *et al.*

2020: 3; Kankisingi and Dhliwayo 2022; Matekenya and Moyo 2022). However, the implementation of technology in manufacturing SMEs may be hindered by a lack of knowledge and financial resources (Mallinguh *et al.* 2020: 3). The manufacturing industry in South Africa has faced difficulties due to a range of issues including insufficient digital infrastructure, noncompliance with regulations, concerns regarding data security, limitations on investment, absence of clear governmental guidelines, and inadequate planning (Maisiri, van Dyk and Coetzee 2021: 2). While a lack of resources is not the only issue, manufacturing SMEs have failed to set aside funds for training in new technologies, which has hindered the successful implementation of such technologies (Ntuli 2022; Msimango 2023; Saruchera and Mpunzi 2023). This has been attributed to a lack of implementation strategy in manufacturing SMEs (Ramírez-Solis and Rodriguez-Marin 2022; Sharma, Raut *et al.* 2023; Mungai and Ndiritu 2023). Without an implementation strategy and adequate skilled labour, implementing new technologies can be difficult and costly (Bomani, Derera and Mashingaidze 2022; Banda and Hapompwe 2023; Saruchera and Mpunzi 2023). These prerequisites for technology adoption have led to manufacturing SMEs' reluctance to adopt technology (Nunden *et al.* 2022; Mhlongo and Daya 2023). In addition, regulatory complexity hinders successful implementation and the ability of SMEs to comply with regulations (Mkhize 2022; Zayed *et al.* 2022; Zhou and Zondo 2023a). Manufacturing SMEs should also consider devising strategies against cyber threats in the process of technology implementation (Jubane 2022; Bandari 2023; Mbandlwa 2023).

3.1.4.5 Confirmation

The final stage of the innovation diffusion process is confirming the acceptance of the innovation, which is based on the merits of the technology in meeting the needs of the firm (De Jong, Rigtering and Spaans 2023). The ability to engage with the innovation and effectively utilise it with ease signifies confirmation of the acceptance of the innovation (Arumugam *et al.* 2022; Nazir *et al.* 2023). System performance is also an indicator for confirming the effectiveness of an adopted technology (Nakasolya 2022; Mbonyane *et al.* 2023). The efficiency of an adopted technology can confirm whether the innovation will improve the success of a manufacturing SME (Lutfi 2022; Soni *et al.* 2022). Manufacturing SMEs can assess the impact of a technology on important

key performance indicators such as return on investment, customer engagement, and customer satisfaction (Nazir *et al.* 2023; Pfister and Lehmann 2023). This can be achieved by monitoring the results of adopting the technology, such as increased efficiency, decreased operating costs, and improved customer satisfaction (Van Nguyen *et al.* 2022; Javaid *et al.* 2022).

The DOI theory has the potential to improve understanding of the challenges facing SMEs and also to assist in the formulation of a framework that can serve as a road map for successful implementation of technologies by manufacturing SMEs. Ali *et al.* (2021) and Amini and Jahanbakhsh Javid (2023) assert that the DOI theory is critical to understanding IT adoption stages and enables faster implementation of technologies. According to Lose and Kapondoro (2020: 8276), SMEs' adoption of business-related technologies is a critical component of South African innovation discourse and policy. While studies conducted by Apulu, Latham, and Moreton (2013: 72), and Issa, Lucke, and Bauernhansl (2017: 670) highlighted the power of ICT to enhance manufacturing processes and create competitive advantage in developed countries, studies conducted by Jeza (2021) and Mkhize (2022) emphasise that manufacturing SMEs in KZN continue to struggle with ICT adoption at various levels. The DOI theory can be used to better understand technology adoption and diffusion by dissecting, interrogating, and explaining the elements that determine how and why consumers choose to embrace a new system (Khan, Qudrat-Ullah 2021). However, the limitations of the DOI theory prevent it from being entirely helpful in understanding the reasons for non-adoption of technologies.

3.1.5 Theory of reasoned action

The theory of reasoned action (TRA) was developed by Ajzen and Fishbein (1975), who initiated a study to investigate the correlation between attitude and behaviour after recognising that attitude alone was insufficient to predict behaviour (Saini and Singh 2020; Khalil, Horgan and Zeuthen 2022). The TRA is based on the value-expectancy theory, which asserts that people will change their conduct or embrace new behaviour if they expect to gain personally from the result. This implies that manufacturing SMEs will be more likely to make changes or accept new practices if the advantages are greater than the drawbacks. The TRA suggests that actions taken by SMEs are

shaped by the goals of the SME and the influence exerted by others (Ngafeeson and Gautam 2021: 28). SMEs' perception of the anticipated consequences of a decision to adopt technology, along with their subjective evaluation of the advantages and disadvantages, greatly affects their attitude towards technology adoption (Al Balushi, Locke and Boulanouar 2018). Prior knowledge, beliefs, past actions, and societal influence may all discourage manufacturing SMEs from taking adaptation and mitigation actions (Ngo *et al.* 2018: 2). Bugwandin (2022) and Khuzwayo (2023) argue that the TRA can only be used to explain actions taken voluntarily by an SME owner; other actions taken by manufacturing SMEs do not necessarily meet the criteria for use of the TRA.

3.1.6 Theory of planned behaviour

The theory of planned behaviour (TPB) was developed by Icek Ajzen, a social psychologist, in 1980. The TPB argues that the outcome of an individual's behaviour depends on their level of motivation (intention) and their level of capability (behavioural control) (Ajzen, Fishbein, Lohmann and Albarracín 2018). It breaks down beliefs into three types: how we act, what is considered normal, and what controls us. Figure 3.2 below shows the blueprint that the TPB can provide for manufacturing SME to understand and predict the influence of their beliefs on specific actions or decisions with regard to technology adoption.

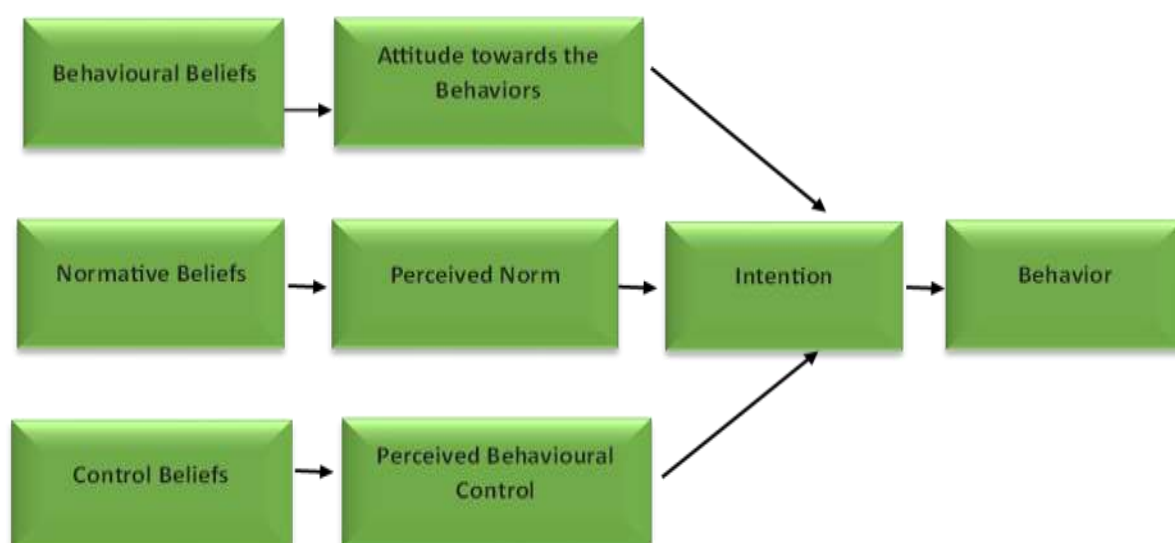


Figure 3.2: Theory of planned behaviour (Ajzen and Fishbein 2010)

In the context of manufacturing SMEs, applying the TPB can assist in understanding how SMEs perceive technology adoption and how they react to potential changes brought by technology adoption (Khayer *et al.* 2020; Lamola 2021; Gwala and Mashau 2023). Such changes might involve introducing and integrating new technologies and amending safety rules or manufacturing processes such as quality assurance (Ncube 2022; Mwale 2022). A manufacturing SME's capacity to identify potential enablers of desired behaviours and impediments to such behaviours can promote an innovative culture among its employees (Amini and Jahanbakhsh Javid 2023; Khoa 2023). In order to achieve this, manufacturing SMEs should develop interventions to overcome resistance to change and promote the adoption of new practices by evaluating employees' attitudes, subjective norms and perceived behavioural control (Schmidt, Riley and Swanson Church 2020; Torlak *et al.* 2021; Ahmad *et al.* 2023). To foster organisational inventiveness, manufacturing SMEs should use the TPB to identify factors influencing employee acceptance of technology that are specific to each SME (Zamani 2022; Santini *et al.* 2022). In addition, they should develop strategies that include providing training and education, offering incentives, and creating a supportive culture that encourages innovation (Mtshali 2019; Matsheke 2022).

With the increasing awareness of environmental sustainability, manufacturing SMEs are under pressure to adopt more eco-friendly practices to promote sustainable operations (Singh and Sarkar 2019; Wijekoon and Sabri 2021; Van Nguyen *et al.* 2022). The TPB can help manufacturing SMEs to understand their employees' attitudes, social norms, and perceived behavioural control in relation to sustainability initiatives (Rakshit *et al.* 2021; Bruce *et al.* 2023). By assessing these factors, manufacturing SMEs can develop targeted interventions to promote sustainable behaviours such as waste reduction, energy conservation, and responsible resource usage among employees (Caldera, Desha and Dawes 2019; Bakar *et al.* 2020). The TPB can also be useful in assessing the intentions and behaviours of suppliers or partners in the manufacturing supply chain (Khan *et al.* 2022; Mukherjee *et al.* 2023).

As applying the TPB requires an understanding of research, planning, and the manufacturing process, interventions may be needed to assist SMEs that lack the particular expertise and finances required to do this (Ncube 2022; Alanazi, Freeman

and Tootell 2022). In addition, manufacturing SMEs may have complex organisational structures and hierarchies that can complicate the application of the TPB (Płonka, Grobelny and Michalski 2022; Malik 2023). There may be numerous individuals involved in decision making in such structures, which may lead to challenges in reaching a consensus regarding business behaviour and perspectives (Rodgers and Nguyen 2022; Becker *et al.* 2023).

In manufacturing SMEs, the application of the TPB often entails continuously promoting behavioural change and adopting new practices, particularly if employees have ingrained habits or are sceptical about the benefits of change (Mweemba 2022; Kenye-Duma 2022). Overcoming resistance to change and fostering a culture that embraces innovation requires strong leadership, effective communication, and the provision of adequate support and training (Said *et al.* 2022; Antony *et al.* 2023). Manufacturing SMEs operate in a dynamic market environment that is influenced by factors beyond their control (Harrison and Pooe 2022; Vilakazi and Ponte 2022; Robertson *et al.* 2022). These factors, which include economic conditions, industry trends, and customer demands, impact the effectiveness of TPB interventions (Ncube 2022; Khan *et al.* 2022). Therefore, in order to adapt to external factors and align TPB strategies with market conditions, manufacturing SMEs must conduct continuous monitoring, be flexible, and be able to adjust interventions accordingly (Senekane 2022; Matsheke 2022). Manufacturing SMEs can use the TPB as a framework to develop targeted strategies aimed at enhancing employee motivation, adopting new technologies, catering to customer needs, and embracing sustainability (Mansor 2022; Van Zyl 2022). Such initiatives contribute to improving competitiveness and sustaining long-term success in the manufacturing industry (Khoza, Mafini and Okoumba 2022; Bugwandin 2022).

3.1.7 Task-technology fit and process virtualisation theories

The task-technology fit theory aims to describe and predict how potential users use and respond to technologies that are designed to help them complete tasks. As the value of a technology is difficult to measure due to the complexity of interactions among technologies, users, systems, tasks, and processes, the task-technology fit theory was developed by information systems experts to enhance understanding of

the function of ICT and its impact on businesses operations (Spies, Grobbelaar and Botha 2020: 397; Goodhue and Thompson 1995; Overby 2008). The task-technology fit theory is concerned with how well a technology is suited to a particular task (Overby and Konsynski 2010: 2). A technology with a better fit to a particular task will be utilised more frequently and produce better results than a technology that is poorly suited for the task. While specific task characteristics will differ depending on the environment, an effective approach to applying the task-technology fit theory is to analyse task execution within a specific setting and create distinct groups and subgroups of tasks that can be aligned with specific technologies (Spies, Grobbelaar and Botha 2020: 399). The task-technology fit theory asserts that “task characteristics” and “technology characteristics” influence fit; according to Overby and Konsynski (2010: 2), this is logical but too vague to provide generalisable, prescriptive direction on how to forecast or enhance fit.

The process virtualisation theory aims to explain and forecast whether processes that have historically been carried out in physical environments, particularly those based on IT, can be transferred to virtual environments (Overby and Konsynski 2010: 2).

3.1.8 Unified theory of acceptance and use of technology

The unified theory of acceptance and use of technology (UTAUT), which was proposed by Venkatesh, Morris, Davis, and Davis in 2003, incorporates numerous theories to explain why people adopt new technologies. The UTAUT has become an increasingly popular framework in the manufacturing industry to explain and forecast employees’ intentions to use technology (Ahmed *et al.* 2020; Pieters, Kokkinou and van Kollenburg 2021).

The UTAUT can be used by manufacturing SMEs to assess the effectiveness of technology implementations and the impact of technology acceptance and usage on a firm’s performance (Lutfi 2022; Pandey *et al.* 2023). Using the UTAUT enables easy identification of areas where manufacturing SMEs’ use of technology could be improved (Chinniah 2021; Etim 2021). The UTAUT can also be used to establish why some technology applications in manufacturing SMEs may have been more successful than others (Ikumoro and Jawad 2019; Venkatesh 2022). An understanding

of why certain technologies have been used more extensively and have resulted in higher levels of employee satisfaction will assist owners of manufacturing SMEs to replicate successful processes in other areas of their business (Toke and Kalpande 2020; Khan *et al.* 2021). Additionally, the UTAUT enables the identification of potential risks associated with technology implementations, which can increase the awareness of potential impediments to the technology adoption process (Mullins and Cronan 2021; Sharma *et al.* 2022).

However, implementing the UTAUT requires multiple changes within the organisation, which can be difficult and costly for manufacturing SMEs to undertake (Selase *et al.* 2019; Saruchera and Mpunzi 2023). Studies conducted by Nkosana (2022) and Dlamini and Garatsa (2021) indicate that manufacturing SMEs have struggled to develop new processes to measure the success of their technology implementations based on the UTAUT.

3.2 Theories adopted for this study

After careful consideration and analysis of the theories discussed above, the TAM and the TOE framework were selected as theories to underpin this study.

The TAM is one of the pioneering theories within the field of technology acceptance. After undergoing rigorous testing, the TAM has consistently exhibited excellent functionality when used in various business settings and with different technologies. As noted in Section 3.1.1 above, many scholars have expressed their support for the model's predictive proficiency and its capacity to aid small businesses in grasping technology implementation. The TAM has been used in a variety of organisations to design accessible technologies and systems and to analyse the feelings of users. It has proved to be highly beneficial and straightforward to utilise.

The TOE framework aims to facilitate comprehension of technology adoption within an organisation and is designed to incorporate both internal and external elements. Like the TAM, the TOE framework has been tested and has proved effective in a variety of sectors and entities, as noted in Section 3.1.2 above. Modifications to the TOE framework by various scholars have rendered it more precise and trustworthy,

thereby confirming its functionality. Interest in the TOE framework has grown among businesses, especially those in manufacturing, because it provides a complete and all-encompassing approach that enables them to gain a comprehensive understanding by examining both internal aspects of the organisation, such as organisational structure and technology, and external factors, such as the surrounding environment. Such an approach can enable managers of manufacturing SMEs to make strategic decisions regarding technology implementation.

In conclusion, the TAM and the TOE framework have both had enduring influence due to their historical context, their adaptability, thorough empirical confirmation, and the trust that has been placed in them by scholars and organisations over many years. These models have consistently been found to be relevant and reliable, which confirms their suitability as tools for comprehending and directing the use of ICT in manufacturing SMEs and other entities.

3.3 Conceptual framework

An in-depth analysis of the literature, theories related to technology adoption, and insights gained from managers of manufacturing SMEs and technology experts revealed specific variables that influence the adoption of 4IR technologies by manufacturing SMEs. Figure 3.3 below shows the conceptual framework that was formulated on the basis of these findings. The conceptual framework uses the TAM and the TOE framework to enhance understanding of the adoption of 4IR technologies by manufacturing SMEs.

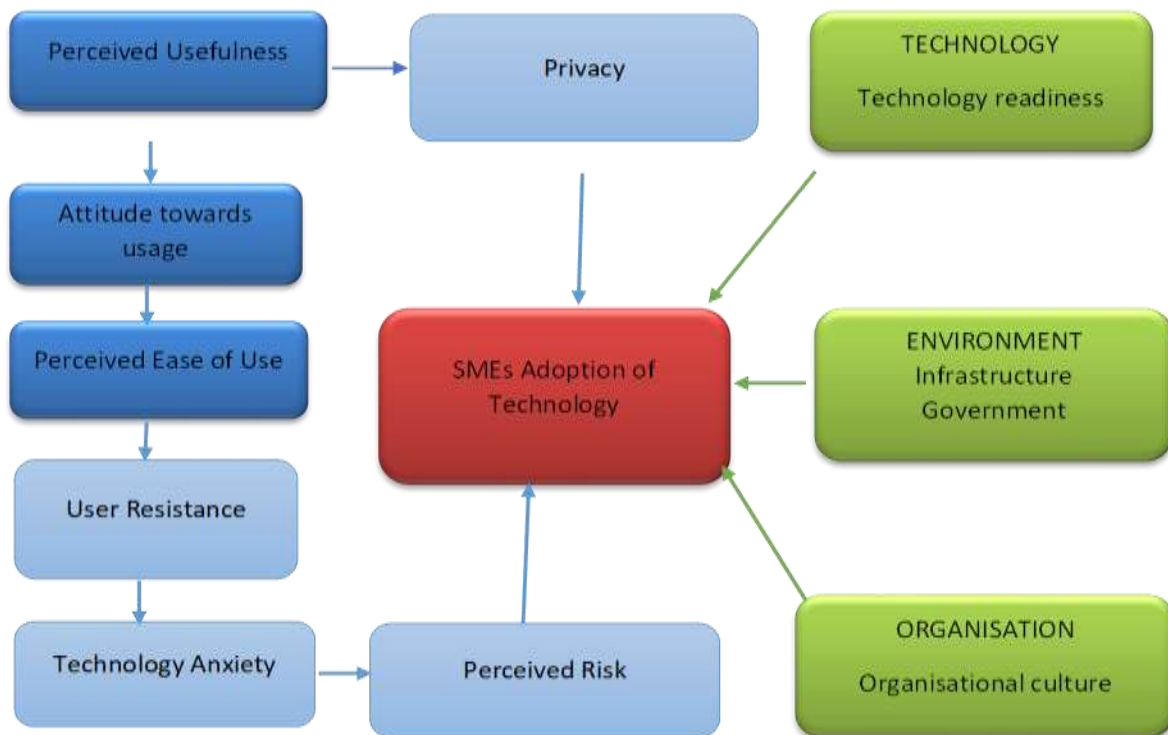


Figure 3.3: Conceptual framework

The growth and sustainability of the manufacturing SME sector are influenced by several factors. This study focuses on the elements that have been found to have an influence on the adoption of technology by manufacturing SMEs, which are depicted in the study's conceptual framework. The TAM factors include variables such as perceived usefulness, PEOU, attitude towards usage, perceived risk, privacy, user resistance, and technology anxiety (Kamal *et al.* 2020: 4; Kelly and Palaniappan 2023; Gupta *et al.* 2023). The TOE factors include the technological context, the organisational context, and the environmental context, all of which influence how a firm absorbs and implements technological innovations (Alkhalil *et al.* 2017: 4; Gwala and Mashau 2023; Zhou and Zondo 2023a).

These variables are significantly relevant in this study and provide guidance in addressing the challenges associated with the adoption of technology by manufacturing SMEs in KZN. Studies conducted by Katebi *et al.* (2022) and Chittipaka *et al.* (2022) found that integrating the TAM and the TOE framework was beneficial in understanding and predicting technology adoption within manufacturing SME contexts. Combining the TAM and the TOE framework can enable manufacturing

SMEs to better capture the complexities and drivers of technology adoption, thus enabling more accurate predictions of adoption outcomes (Mitra, Kapoor and Gupta 2022; Tiwari *et al.* 2023). This knowledge can guide manufacturing SMEs in focusing their efforts on addressing these critical factors in order to facilitate successful technology adoption (Ghobakhloo *et al.* 2022; Weger *et al.* 2023; Mkansi and Nsakanda 2023).

3.4 Summary

This chapter has provided a succinct account of theories that assist in understanding the implementation of 4IR technologies. It has discussed the use of the TAM and the TOE framework to explore the determinants that lead to the acceptance of 4IR technologies and the compatibility of these technologies within the manufacturing sector. It has also discussed the use of the DOI theory to examine the process by which technology is integrated into manufacturing processes to enhance productivity. In addition, it has discussed the use of the DCT to emphasise the importance of flexibility and adaptability in manufacturing SMEs, as well as the use of the TRA and the TPB to predict future trends and enhance competitive edge. Collectively, these theoretical frameworks provide insightful knowledge into the complex process of technology adoption.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

The previous chapter introduced the conceptual framework for this study, which is derived from the TAM and the TOE framework. The chapter also identified and discussed issues surrounding technology adoption by manufacturing SMEs in KZN.

This chapter examines the techniques used to undertake this study and presents the methodology used to understand and apply relevant knowledge. The chapter discusses the study's research approach, population, sampling technique, data collection instrument, information gathering approach, and data analysis techniques. The chapter also highlights the ethical issues arising from this study, validity and reliability issues within the mixed-method approach, and the adopted explanatory sequential approach. In addition, the chapter explains the role of the research methodology in aiding the exploration of how the adoption of 4IR technology by manufacturing SMEs in KZN has enhanced their sustainability.

4.2 Research design

A research design is the approach and framework of an inquiry that is created with the intention of finding solutions to the research questions (Blumberg, Cooper and Schindler 2014: 152). Such a plan should explicitly outline how research questions will be addressed (Saunders *et al.* 2015). The chosen research design should provide a framework that helps to identify the necessary procedures for obtaining relevant information to address the research problem and objectives (Creswell and Creswell 2018: 12). There are multiple elements to take into account when deciding on research design, and determining how to conduct research directly influences the way in which researchers gather relevant information (Sileyew 2019). A research design explains the procedure of gathering and analysing data and the application of research techniques to address the study's objectives (Mofokeng, Giampiccoli and Jugmohan 2018: 16). A solid research design reduces frustration by acting as the glue that holds

the essential components of a research project together (Jongbo 2014: 90). Collecting data without first considering the variables influencing the study design and the kind of data required to address the research questions would probably lead to inadequate and flawed study results (Asenahabi 2019: 78).

This study aims to develop a framework that can provide practical guidance for the adoption of 4IR technologies by manufacturing SMEs in KZN. The mixed-method and explanatory sequential approaches were chosen on the basis that the limitations of one approach are addressed by the other. A mixed-method explanatory sequential design involves utilising both qualitative and quantitative techniques in a systematic manner to comprehensively comprehend a research issue (Ngulube 2022; Ghods *et al.* 2023).

To plan the study project, the researcher initially established specific objectives and research questions, which were driven by a thorough literature analysis to determine current knowledge gaps. The researcher then identified an acceptable methodology, using a combination of methodologies that incorporates qualitative and quantitative data. The target demographic and sampling methodologies were chosen to provide a sample that was representative, and thorough data collecting and analysis methods were developed, incorporating the application of interviews and questionnaire. Ethical factors including informed consent and anonymity were considered. Furthermore, a timeframe and resource strategy were developed, and a pilot study was undertaken to improve the research design. This systematic methodology ensured that the research effort was rigorous, ethical, and complete.

4.3 Research philosophy

A research philosophy is a set of beliefs and assumptions about how knowledge develops (Saunders *et al.* 2015: 16). It reflects the evolution of study assumptions, implications, and expertise in the field (Damamisau *et al.* 2020). While the assertions of a study may appear to be an initial affirmation of a process of reasoning, they are based on deeper insight provided by theories, which are the outcome of scholarly effort. In order to produce high-quality research, it is critical to ensure that the design of a study is extensive enough to support the research philosophy of the study

(Saunders *et al.* 2015: 16). A research philosophy aids in the adoption of suitable approaches and methods by allowing the researcher to investigate various possible methodologies and to choose relevant methods (Kornberger and Mantere 2020: 3). The chosen philosophy not only informs how the research problem will be addressed but also assists the researcher in effectively incorporating all the relevant research elements in a project (Saunders *et al.* 2015: 124). Failing to select an appropriate philosophy may result in the integrity, validity, application, and credibility of the study being called into question (Kivunja and Kuyini 2017: 26). Therefore, it is of paramount importance that a study's methodological approach is suited to the philosophy adopted for the study.

Pragmatism is a research philosophy that originated with the perception that there is no one-size-fits-all approach to understanding concepts (Saunders, Lewis and Thornhill 2016). Various research approaches, including both the quantitative and qualitative research approaches, are thus used to acquire an understanding of different viewpoints (Rahman 2020). Pragmatism emphasises the correlation between the actions of study participants and their past experiences, as well as the influence of anticipated outcomes on their decisions; it also acknowledges that the beliefs and experiences of participants may differ (Kaushik and Walsh 2019: 4). For a pragmatist, explanatory research involves collecting and examining numerical data, followed by the analysis and interpretation of descriptive information to offer a more comprehensive explanation to elaborate on the numerical findings (Walliman 2021). A pragmatist philosophy is frequently used in conjunction with mixed or multiple-method studies in which the outcomes of the study and the research objectives are prioritised (Kaushik and Walsh 2019: 3). In this study, a mixed-method explanatory sequential approach was utilised due to its ability to provide an improved understanding of the research problem, thus enabling the researcher to gain a better understanding of issues confronting manufacturing SMEs in KZN than might have been accomplished using only a single research approach. An essential tenet of pragmatic research is the notion that every research project ought to be driven by the goal of providing valuable data, addressing deeper issues, or redefining unclear situations in light of an examination of successful procedures (Kelly and Cordeiro 2020: 3). A pragmatist philosophy was adopted for this study in order to gain a deeper comprehension of the attributes that influence decision-making with regard to the

adoption of 4IR technology by manufacturing SMEs in KZN, and thereby to address the research questions and provide a balanced conclusion that contributes to the body of knowledge.

4.4 Research methodology

A research methodology is a strategy that outlines the stages and methods to follow when performing a research study and thus provides a technique to address research issues correctly (Engler and Stausberg 2021: 4). Research methodologies encompass various techniques and procedures employed to conduct research with the aim of ensuring that the research questions are answered (Liamputtong 2019). Three methodologies are used in social science research: statistical, qualitative, and blended (Kumar 2014: 22). Blended or mixed-method research is a combination of qualitative and quantitative methodologies (Creswell and Hirose 2019: 4). The purpose of a mixed-method approach is to compare and corroborate the results obtained through multiple methods, which is referred to as triangulation (Schoonenboom and Johnson 2017). In a mixed-method study, comparing the results obtained through multiple methods enables the researcher to lessen the influence of potential bias by carefully reviewing the data to improve the reliability of inferences and to draw well-informed conclusions (Othman, Steen and Fleet 2020: 71). In addition, comparing results affords the researcher the opportunity to gain in-depth insight into data initially collected through a survey by following up with interviews that assist in explaining the survey results in more detail (Creswell and Hirose 2019: 2).

Collecting data through quantitative techniques from several subjects increases the probability that the findings could prove applicable to a larger population (Dawadi, Shrestha and Giri 2021: 3). In contrast, the qualitative approach places importance on the opinions and perspectives of the participants, thereby enhancing comprehension of the subject matter. Mixed-method studies provide valuable insights beyond quantitative or qualitative data analysis and enable researchers to apply results and implications to the entire population (Creswell and Hirose 2019: 3). Through the use of a variety of approaches to explore research issues and topics, mixed-method studies create possibilities for enhanced levels of application (Graff 2014: 48).

4.5 Population

A study's population is the full set of cases needed for the researcher to draw a conclusion (Schoch 2020). A study focuses on the population of interest, which includes individuals, organisations, or entities to which the findings can be applied (Casteel and Bridier 2021: 343). The population targeted for a research study should reflect characteristics that are relevant to the research project (Martínez-Mesa *et al.* 2016: 326). Understanding the characteristics of a given population is critical in ensuring data quality, reducing research costs, and obtaining acceptable response rates (Neuman 2014). In addition to enabling the researcher to study the phenomena of interest or issues affecting the population, the target population should be able to provide results that can be generalised to the entire population (Privitera 2022). The participants in this study included managers of manufacturing companies in KZN and IT specialists employed in the commercial sector. IT experts were engaged in order to acquire in-depth knowledge about the 4IR technologies utilised by manufacturing SMEs in KZN as well as their perspective on the incorporation of technology into manufacturing processes. It can be challenging to grasp the intricacies of manufacturing technologies as they tend to be highly specialised, and manufacturing SMEs may lack the necessary capabilities and knowledge to independently develop or utilise specific technologies (Radicic and Petković 2023: 3). Hence, there is a need for manufacturing SMEs to seek assistance from technology vendors and consulting companies that possess the ability to aid them in determining and implementing the most appropriate technologies for their specific needs.

In order to establish the target population for this study, both SEDA and the Durban Chamber of Commerce were requested to provide a list of registered manufacturing SMEs. Their responses indicated that they were required by the Protection of Personal Information Act to keep information about manufacturing SMEs confidential and could only share such information with members. Subsequently, the contact details of manufacturing SMEs were obtained by means of a Google search. According to Kyalangalilwa (2021) database, the population of manufacturing SMEs across KZN is estimated to be 30 996. According to Huawei (2020), the estimated number of registered IT companies in KZN is 20 000.

4.6 Sampling

Sampling entails selecting a subgroup of participants from which the findings can be easily generalised to the whole population (Sharma 2014: 208). Through sampling, a researcher can choose, analyse, and make inferences from a large enough sample of a population to allow for the generalisation of attributes to the group under investigation (Kumar 2014; Sekaran and Bougie 2013). The information acquired from the sample should provide correct judgments about the total population (Levy and Lemeshow 2013). While the validity of data collected through a single method is questionable as the data may be biased or weak, the utilisation of a diverse range of collection methods and sources aids in obtaining conclusive data (Zohrabi 2013: 258). A sample design is a blueprint for selecting a sample from a specific population; it outlines the strategy or approach used by the researcher to select the sample (Cooper and Schindler 2014: 84).

Convenience sampling is a type of nonprobability sampling in which participant selection is based on meeting specific criteria for inclusion in a study, such as easy access, nearby location, accessibility at a specific time, or desire to participate (Elfil and Negida 2017: 2). Purposeful sampling refers to the deliberate selection of respondents based on their characteristics (Etikan, Musa and Alkassim 2016: 2). This is a non-random approach that would not necessitate any key assumptions or a prearranged number of respondents. Purposeful sampling is typically employed by qualitative researchers with limited resources to deliberately identify and select samples that possess valuable information and expertise in a specific subject (Palinkas *et al.* 2015: 2).

In this study, data were collected from executive managers of manufacturing SMEs and IT experts in KZN. A non-probability sampling strategy with a convenience sampling approach was used to collect quantitative data and a non-probability sampling strategy with a purposeful sampling approach was used to collect qualitative data.

The quantitative sample consisted of executive-level manufacturing SME managers located in KZN and included both users and non-users of 4IR technologies. The

convenience sampling method was considered suitable for the collection of quantitative data because the survey respondents were easily accessible. The qualitative sample consisted of industry experts in the commercial field. A purposive technique was adopted to collect qualitative data due to the level of expertise in the sample.

The sample for this study included 384 registered SMEs in the eThekweni district in KZN and 10 IT experts in the commercial sector, as shown in Table 4.1 below. According to Sekaran and Bougie’s (2016) sampling table, 384 is an acceptable sample size. Fink (2013: 44) recommends 10 as an ideal number of participants for interviews.

Table 4.1: Sampling distribution

Respondents	Type of data collection	Sample
IT industry experts	Phase One – Qualitative	10
Manufacturing SME managers/owners	Phase Two – Quantitative	384
Total		394

4.7 Data collection

Data collection entails the accumulation and analysis of facts about characteristics of interest in a structured way that allows the principal investigator to address the research questions (Dawadi *et al.* 2021). Data gathering is a systematic procedure that involves acquiring and evaluating data on relevant factors in order to test research questions and analyse findings (Sekaran 2013; Kabir 2016: 202). This is done to a particular level in order to address the research questions with authenticity (Polit and Beck 2012). Data can be accumulated from primary or secondary sources, or both (Sekaran and Bougie 2016). Primary data refers to data collected directly by the researcher, such as data received from respondents, while secondary data refers to data that were previously gathered by another party (Ajayi 2017: 2). Primary data were used in this study due to their originality and their greater validity and reliability than secondary data that have been modified (Kabir 2016: 204). In addition, the use of primary data allows the researcher to obtain more data during the research process should the need arise (Creswell and Hirose 2019). Secondary data were used in this study to gather relevant information from multiple sources and past investigations in

order to understand the dynamics and scope of the study (Kalu, Unachukwu and Ibiam 2019: 54). The use of secondary data takes away the burden of ensuring the accuracy of the data from the researcher (Sekaran and Bougie 2016).

In this study, two research instruments were used to collect data: questionnaires, which were distributed both in person and online, and semi-structured in-depth interviews. Challenges were encountered with obtaining a list of registered manufacturing SMEs in KZN due to the newly introduced Protection of Personal Information Act, which prohibits access to personal information of individuals without their permission. This negatively impacted the data collection process in this study. While in-person distribution of the questionnaires resulted in a reasonable response rate, the online survey achieved a low response rate. Despite numerous requests and reminders being issued to participants to respond to the survey, the desired outcomes were not achieved. The low response rate can be attributed to the disturbances caused by looting that took place in July 2021 and the floods that took place in KZN from 11-13 April 2022, both of which negatively impacted manufacturing SMEs.

4.7.1 Questionnaire

A questionnaire is a standardised instrument that contains questions and is used to collect data from participants (Sekaran and Bougie 2016). Due to their capacity to cover large sample numbers for a study that utilises multiple approaches, questionnaires are often regarded as a credible research instrument for studies that combine quantitative and qualitative methods to produce findings that can be generalised (Harris and Brown 2019: 2). The use of an appropriately designed questionnaire can improve a research project's validity and reliability and enable the researcher to save time and money (Polonsky and Waller 2011: 94). This study utilised secondary data sourced from literature to inform the development of a questionnaire which could be used as a tool to shape the study's objectives (Pandey and Pandey 2021). The use of secondary data was crucial in ensuring that the questionnaire was well-designed so that respondents could efficiently perform their role in the study (Bergkvist and Langner 2023).

Even though the use of questionnaires is generally practical and enables reaching a large number of respondents, it was not found to be a cost-effective method for data collection in this study. The respondents were located across the province of KZN, which necessitated the appointment of a research assistant to administer the questionnaires. The research assistant was a master's degree student at DUT who had completed a similar project in their bachelor's degree programme and thus had prior experience in research and gathering data. The principal investigator orientated the research assistant to the overall research project, explained the context of the study and its objectives, demonstrated to the assistant how to approach manufacturing SME managers, and ensured that the assistant was able to make contact should there be any issues during the data collection process. In addition, the principal investigator established a coherent strategy for effective communication by consistently requesting the assistant to provide updates on the progress of the data collection process, which included reporting on challenges encountered.

Data were gathered from managers of manufacturing SMEs by means of a questionnaire. Section A of the questionnaire requested background details about the manufacturing SMEs. These details assisted in understanding the characteristics of the sample being studied. Section B consisted of nine statements that focused on comprehending the utilisation of 4IR technologies by manufacturing SMEs in KZN. Section C consisted of 10 statements focusing on the positive outcomes of adopting 4IR technologies for SMEs in the manufacturing industry. Section D consisted of 11 statements that focused on the limitations that manufacturing SMEs encounter when implementing 4IR technologies. Section E consisted of 11 statements which focused on the strategies used by manufacturing SMEs in KZN to overcome challenges in implementing 4IR technologies. A qualitative segment of the questionnaire investigated the collaboration of the manufacturing SMEs with other firms, the strengths of the technologies adopted by the manufacturing SMEs, and any additional challenges that had been experienced by the manufacturing SMEs.

Participants were requested to indicate their level of agreement with the statements in sections B, C and D according to a five-point scale in which a rating of 1 represents strong disagreement, a rating of 2 indicates disagreement, a rating of 3 signifies no

opinion, a rating of 4 indicates agreement, and a rating of 5 denotes strong agreement. The questionnaire is shown in Appendix A.

4.7.2 Interviews

The use of structured interviews entails that the researcher develops an interview schedule in advance and ensures that similar questions are posed in an unchanged manner without deviation (Sekaran and Bougie 2013: 120). This enables the interviewer to easily create themes.

An assessment of secondary data revealed a gap that had not been addressed by earlier research. The gap involves a notable absence of expertise and in-depth guidance on practical techniques to assist SMEs in the manufacturing sector to effectively integrate innovative technologies. If this gap continues to persist, the long-term sustainability and growth of SMEs in the manufacturing sector will be impacted and these SMEs will continue to fall behind established competitors. The interview questions created for this study focused on addressing this gap.

Semi-structured interviews feature a series of open questions that enable the investigator to obtain critical information while also allowing flexibility to develop specific themes or responses further (Solarino and Aguinis 2021). This study used semi-structured interviews to focus on themes of interest to the study while also obtaining much-needed additional insights from SME managers. Ruslin *et al.* (2022) note that semi-structured interviews can corroborate the findings of a survey and reduce the margin of error.

The interviews were conducted in accordance with the sequential design of this study. Initially, in order to establish the range of technological applications currently available and their applicability to manufacturing SMEs, 10 IT specialists who were employed in the commercial sector and had technical expertise in 4IR technologies were interviewed. The data obtained from these interviews contributed to the design of the questionnaires, which were subsequently distributed to managers of manufacturing SMEs.

The interview schedule consisted of 10 questions which aimed to obtain an understanding, from the IT experts' perspective, of factors that impede 4IR adoption by manufacturing SMEs. The interview schedule is shown in Appendix C.

4.8 Dissemination of the research instruments

Questionnaire administration is the process of contacting respondents to gather the data needed for a survey (Ramsuraj 2020). The use of multiple methods to disseminate the questionnaire enabled primary data to be obtained from respondents by email, by telephone, in person, and through self-administered surveys. The dissemination process ensured that the data gathered were reliable as they were collected in real time. The use of secondary data from sources such as journals, government publications, and textbooks facilitated the discovery of fresh ideas from the primary data.

The dissemination process involved both online and in-person data collection methods. Firstly, an online survey was conducted by means of a Google Form. Government agencies were requested to assist in disseminating the online survey as the researcher had limited access to the database. Secondly, a research assistant was appointed to administer questionnaires to participants in person. The research assistant ensured that COVID-19 guidelines were adhered to by consistently wearing a mask, sanitising, and maintaining the required distance from participants. In addition, online interviews were conducted to acquire in-depth information from three managers of manufacturing SMEs in KZN. To ensure that COVID-19 protocols were adhered to and to allay the research participants' fears of COVID-19 transmission, the interviews were initially planned to be conducted online via Microsoft Teams. The interviews were scheduled to begin on 5 July 2022, but this did not materialise as expected due to the unwillingness of potential research subjects to participate in the study. Despite repeated requests via email and telephone calls, most of the participants were unreachable or had other commitments. The first interview took place on August 15, 2022.

Data from 10 commercial IT system experts were gathered using a multi-purpose technique involving telephonic and face-to-face interviews. The interviews were

recorded in order to verify the accuracy of the transcripts and to ensure the accuracy of quotations used in the study. Permission to record the interviews was obtained from the interview participants. The interview participants were informed that copies of the interviews would be available on request prior to publication of the study.

4.9 Pilot testing

A pilot test is carried out to identify flaws in a research instrument and to provide sample data (Cooper and Schindler 2014; Rahi, Alnaser and Abd Ghani 2019: 1159). A pilot test evaluates various facets of a larger population on a smaller sample to gauge respondents' reactions (Shrestha *et al.* 2020; Nowell *et al.* 2021). The results obtained from the pilot test can expose actual and potential vulnerabilities that need to be resolved before the study is undertaken (Velardo and Elliott 2021). Rather than serving as a trial of an already established plan, a pilot test enables the researcher to better understand the development of an approach to the study (Pandey and Pandey 2021). The purpose of a pilot test is to enable adjustments to be made to a research instrument so that participants do not encounter difficulties responding to the questions, and participants in a pilot study should give consent to fully participate in the process of obtaining relevant information (Saunders, Lewis and Thornhill 2016: 473). Fink (2013: 44) recommends a minimum number of participants of 10 for most pilot studies.

In this study, a pilot test was conducted to assess the usability of the research instruments and to determine their practicality for application in a larger study. 50 managers of manufacturing SMEs were randomly chosen to engage in the pilot study, which was conducted in October and November 2021. This was done with the aim of identifying any issues with the questionnaire and resolving them in order to improve the main study's likelihood of success. The participants in the pilot test were carefully instructed in what was expected of them in order to ensure that they would be able to answer all the questions. The participants were provided with a letter of information and consent that provided a thorough explanation of the study topic and objectives. The significance of providing accurate responses to the questions was explained to the participants. 33 questionnaires were received, which provided a response rate of 66%. The findings showed several contradictions; for example, a respondent indicated

in the demographic information section that they were not the owner of an SME but also selected 'owner' as their current position from a list of options. Some respondents expressed only neutral responses. Based on the results of the pilot study, which revealed several vague and contradictory items, the questionnaire was amended in order to eliminate errors. When the final questionnaire was distributed, its contents were fully explained to the participants and the significance of choosing appropriate answers was stressed. The participants were given the option to review the questionnaire and to contact the researcher via email if further clarification on any question was needed. As most of the respondents asked for more than a day to complete the questionnaire, the questionnaires were collected after 72 hours.

To test the effectiveness of the interview schedule, a manager of a manufacturing SME was interviewed telephonically. The results of the interview provided additional in-depth perspectives from the viewpoint of the owner of a manufacturing SME that revealed a deficit in the knowledge of IT experts who specialise in technologies that are suitable for the manufacturing SME sector. This resulted in the inclusion of additional questions that aimed to obtain insight into specific 4IR technologies suitable for the manufacturing industry. The piloting of the research instruments thus resulted in the distribution of tools that were free of errors in the main study.

4.10 Data analysis

Data analysis is the process of making meaning from the collected data in order for the researcher to draw conclusions (Walliman 2021; Khoa *et al.* 2023). This process is characterised by the reduction or elimination of a substantial portion of acquired information in order to create meaning (Sekaran 2016). In this study, the qualitative data was translated and reviewed in order to identify themes that were relevant to the study's goals. The in-depth interviews were analysed using thematic analysis. This process requires that the transcripts are read a number of times with the intention of organising the data in a meaningful way. This revealed recurrent themes which enabled the creation of a comprehensive thematic structure in which all the data were classified and organised according to the themes.

The quantitative data obtained from the questionnaires was analysed using the Statistical Package for the Social Sciences (SPSS) version 26.0 to perform factor

analysis and descriptive analysis. This was done in order to obtain meaningful findings from the questionnaires. SPSS was selected as a statistical tool due to its user-friendliness and its ability to generate descriptive and inferential statistics, to analyse and display data, and to create tables and graphs, all of which enable data to be interpreted easily.

4.10.1 Frequency analysis

Frequency analysis assists in showing the broad outcomes of a study by revealing incidences that fall into the various response categories defined in a research questionnaire (Friginal and Hardy 2014). In this study, patterns and correlations were identified through observing the frequency of occurrences and statements. The use of frequency analysis aided in thorough comprehension of the data and provided new insights.

4.10.2 Descriptive analysis

Descriptive research uses graphs, tables, and pie charts to highlight and contrast key attributes of the results (Mishra *et al.* 2022). Descriptive statistics enable results to be presented in such a way that the information can be easily understood (Laerd Statistics 2015: 2; Khanya 2021: 51).

In this study, descriptive statistics were employed to display and describe data. Descriptive analysis was used to summarise and clarify the data collected on the adoption of 4IR technologies by manufacturing SMEs and to assist readers in comprehending the key attributes of the data, thus facilitating interpretation of the results. The findings were presented using tables and figures for ease of understanding. Frequencies were used to profile the responses of the participants and to show the results. Bar charts, pie charts, bar graphs, and histograms were used to display the findings for constructs that were classified in a variety of ways.

4.10.3 Inferential statistics and chi-square test

Inferential analysis is a set of methodologies that allows a researcher to draw conclusions about a population using data from a sample. It involves a logical analysis of data from a study's population and is primarily focused on the consistency and accuracy of results (Lowry and Gaskin 2014). The use of inferential statistics in this study enabled a more comprehensive understanding and explanation of the variables that were analysed. The study sought to identify any correlations or trends among the various variables examined in order to obtain a deeper understanding of the impact of technological innovation on the long-term development of SMEs. This was achieved through utilising a chi-square test to assess the compatibility and potential associations among the variables under investigation.

4.11 Reliability

When a new measurement instrument is developed, it is frequently recommended that it be tested before being used in a study (Hennink and Kaiser 2022; Poghosyan *et al.* 2019). The questionnaire and interview schedule used in this study were pilot tested to ensure their validity and reliability, to detect any flaws, to clarify ambiguous terms, and to determine if any improvements were needed. Kelly and Wagner (2012: 273) define reliability as the consistency of measurement in which trustworthy data ensures that the evidence and conclusions drawn from a study can stand up to scrutiny.

Tests for data reliability include Cronbach's alpha test, which was used in this study. In the questionnaire, participants were asked to select their level of agreement with each statement from the following options: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. The similarity between the responses of the participants was calculated using Cronbach's alpha in order to determine the accuracy of the instrument; the higher the consistency of responses, the more accurate the instrument is.

Data triangulation and respondent validation can be used to improve a study's reliability and validity (Noble and Smith 2015: 2). A carefully crafted interview schedule, an audio recording of every piece of information gathered, and obtaining the permission of respondents all assisted in ensuring the reliability of this study. To

prevent participants from feeling uncomfortable, the researcher and each respondent agreed on the location of the interviews, and respondents were given the choice to be interviewed telephonically or in person. To ensure the reliability of the questionnaire, all participants were asked the same questions. To ensure the reliability of the interview schedule, respondent validation was used; respondents were asked to provide feedback on the interview schedule in order to assess whether the resultant themes and interpretations accurately represented the phenomenon being studied. Additionally, a triangulation approach was applied to verify reliability and validity by cross-referencing the data gathered in order to identify patterns in the research findings.

4.12 Validity

Validity is an indicator to evaluate whether a research instrument genuinely measures what it is designed to measure; it is therefore a vital requirement for the integrity of the findings of a study (Mustafa *et al.* 2022). Validity signifies the extent to which a study's findings precisely depict what is happening in the real world; a study's validity can be harmed by poor research processes, poor sampling, and inaccurate or misleading measurement (Pandey and Pandey 2021; Saunders, Lewis and Thornhill 2016: 136). Combining methodological approaches increases the validity of a study through cross-validation (Sarstedt and Danks 2022; Alejandro and Zhao 2023). A combined methodology is informed by a design approach in which quantitative research primarily provides validity and reliability, whereas qualitative research adds meaningful deeper understanding by matching occurrences with explanations in interviews (Khoa *et al.* 2023; Pilcher and Cortazzi 2023). Validity and reliability are crucial characteristics of all studies; devoting significant attention to these two characteristics can signify the difference between a successful study and an unsuccessful study and can also ensure that fellow researchers accept the findings as credible and trustworthy (Hendren *et al.* 2023; Krichen 2023). In this study, reputable subject-matter experts provided their perspectives on the validity of the questionnaire as part of a content validity investigation to ensure the validity of the data collection method. Furthermore, a pilot study was carried out to ensure that the sample would be sizable enough for accurate representation. The applicability of the questions was determined partly by an

intensive analysis of the findings of the pilot study, and redundant questions were eliminated from the questionnaire.

Based on the above discussions on validity and reliability, it can be concluded that, the inability to ensure the reliability and validity of both the quantitative and qualitative instruments will have dire implications on the interpretation of research findings (Kurtaliqi, Miltgen, Viglia and Pantin-Sohier 2024: 2). This is because the insights gleaned from both manufacturing SME managers and IT experts into the experiences and impediments that small manufacturing enterprises encounter with 4IR technology adoption will be misleading and will overlook crucial aspects (Munongo and Poee 2022: 7; Khuzwayo 2023: 26). As a result, a study conducted by Foster (2024: 5) cautions that failing to effectively integrate these types of data can create an obscuring narrative, where the statistics fail to clarify the underlying perceptions. As a consequence, this will lead to the current research providing misguided policy proposals, ineffective strategies for seamless technology implementation, complicating efforts to support manufacturing SMEs in adopting new technologies to boost their competitiveness and expand.

4.13 Inclusion and exclusion

Formulating criteria to determine which individuals are eligible or ineligible to participate in a study is a fundamental aspect in ensuring that the study is conducted proficiently. The specific qualities of participants that will be investigated in a study are referred to as inclusion criteria (Patino and Ferreira 2018a: 84). Characteristics or attributes that could reduce the effectiveness of a study or increase the likelihood of unfavorable outcomes, and thus exclude potential participants from the study's population, are referred to as exclusion criteria (Garg 2016: 642). While this study was limited to the province of KZN and its findings therefore cannot be generalised to manufacturing SMEs in other provinces, they can be utilised to improve the sustainability of SMEs in other provinces or to inform future research. As numerous types of SMEs exist, this study focused only on SMEs in the manufacturing sector in KZN with particular attention to the factors that influence the adoption of 4IR technologies to enhance the manufacturing process. In order to ensure that the findings of the study would be relevant and reliable and would accurately reflect the

perspectives of manufacturing SMEs, the study excluded other SMEs in the province. Due to time and resource limitations, the study was conducted only among manufacturing SMEs in Durban, Pietermaritzburg, and Pinetown in the province of KZN. The results of this study cannot be applied to other SMEs that do not engage in manufacturing as their situational circumstances may differ.

4.14 Ethical considerations

Ethics are precepts that regulate a person's actions; in research, ethics refer to principles of correct moral and legal conduct (Israel 2014). Ethics are crucial throughout the research process in all fields of study. Morality refers to the investigator's ability to make decisions and to take responsibility for his or her actions (Bowen 2017). Essential ethical norms in research are universal and include honesty and respect for personal rights (Ulrich 2017). Research ethics include ensuring that data acquired from participants is kept confidential and that their identities are kept anonymous (Kang and Hwang 2021).

On 22 December 2020, a research proposal and ethics checklist was submitted to the Faculty of Accounting and Informatics research office at DUT; approval was granted on 23 March 2021. An application for ethical approval was submitted on 23 March 2021 with the following attachments: the approved research proposal and ethics checklist, ethics training certificate, post review template, supervisor checklist for the Faculty Research Ethics Committee, questionnaire and interview schedule, letters for both instruments, and the curriculum vitae of the researcher; approval was granted on 30 June 2021. This approval constituted permission for data collection for the study to commence.

4.14.1 Letter of information and consent

Informed consent was obtained verbally and in writing from the IT experts and managers of manufacturing SMEs who agreed to participate in the study. The questionnaire (Appendix A) and a letter of information and consent (Appendix B) were distributed to all participants. The letter of information and consent described the study's purposes comprehensively and outlined the advantages and risks of

participating in the study. The information letter and consent form complied with the ethical conformity standards established by the DUT Faculty of Accounting and Informatics Research Committee, by which the study was reviewed. The study was approved under ethical category 2, which required minimal compliance with research ethics.

4.14.2 Anonymity and confidentiality

Anonymity refers to gathering no data that can identify a specific person or organisation, while confidentiality refers to protecting raw data and releasing only aggregated results that cannot be traced to a specific person or organisation (Coffelt 2017; Badampudi *et al.* 2022: 3). To maintain data confidentiality, it is the researcher's responsibility to keep participant information private and to refrain from disclosing it to third parties (Surmiak 2018). It is often a conundrum for researchers to decide whether to prioritise the accurate disclosure of findings, which might potentially disclose respondents' identities, or the concealing of information to protect participants, which might potentially jeopardise the study's validity (Lancaster 2017: 98).

All participants in this study were guaranteed anonymity and confidentiality and were informed that the information they shared would be utilised solely for the purposes of this study. The names of participants who were interviewed were not revealed in the interview transcripts, the identities of participants who participated in the online surveys were kept private, and no personal information was requested from participants to whom questionnaires were distributed physically. None of the participants were identified by name in the dissertation; instead, the focus was on the themes that arose from the qualitative data.

4.15 Conclusion

This chapter presented an overview of the research design, philosophy, methodologies, and a mixed method with a pragmatic approach was adopted for the current study. Moreover, the population, sampling method, adopted instruments, piloting and the process of analysis were further explained. The researcher in this chapter also highlighted the importance of attaining consent from the study

participants prior participation. On completion of piloting stage, the researcher revisited the instruments to make the necessary amendments. The next chapter will discuss and analyse the quantitative data that was collected.

CHAPTER FIVE

INTERPRETATION OF DATA AND DISCUSSION OF RESULTS

5.1 Introduction

The research approach used in this study was discussed in detail in the previous chapter. This chapter presents a thorough analysis of the quantitative primary data obtained from the questionnaires and evaluates and discusses the results in relation to the study's goals. The literature review in Chapter Two provided an extensive overview of the challenges impacting decision making in manufacturing SMEs in KZN with regard to technology implementation, which assisted in the formulation of the study's objectives. This chapter reviews and evaluates the findings of the quantitative analysis with regard to technology adoption by manufacturing SMEs in KZN.

SPSS version 26.0 was used to analyse the data gathered from respondents. Graphs, cross tabulations, and other figures illustrative of the quantitative data that were gathered are used to convey the results in the form of descriptive statistics. Correlations and chi-square test results, which are interpreted using p-values, are two of the inferential approaches used in the analysis of the data.

5.2 Sample

A total of 384 questionnaires were distributed to participants, of which 261 were returned, which provided a 68% response rate. According to Sekaran and Bougie (2016), a response rate greater than 65% is regarded as acceptable for a study. The response rate achieved in this study indicated that an acceptable representation of the population was obtained, which would allow conclusive generalisations to be made. Despite the challenges posed by social distancing regulations due to the COVID-19 pandemic, the multimethod approach used to collect data, which included the use of online surveys and self-administered questionnaires as discussed in Section 4.8 above, enabled the attainment of an acceptable response rate. The response rate achieved in this study is also a clear indication that the questionnaire was understandable by the participants.

5.3 Questionnaire

The questionnaire was divided into six sections, which measured various themes. The sections and themes of the questionnaire are shown in Table 5.1 below.

Table 5.1: Questionnaire sections

A	Demographic data
B	Utilisation of 4IR technologies by manufacturing SMEs in KZN
C	Benefits of the adoption of 4IR technologies by manufacturing SMEs in KZN
D	Barriers to the adoption of 4IR technologies by manufacturing SMEs in KZN
E	Strategies for ICT adoption by manufacturing SMEs in KZN
F	Open-ended questions

The questionnaire's main goal was to identify and analyse the significant internal and external elements that influence manufacturing SMEs' decisions regarding technology adoption. The questionnaire consisted of 54 items, all of which were measured at a nominal or ordinal level. The items in Sections B to E were measured at an ordinal level by means of ratings given to each statement. The statements were categorised into four thematic sections: Section B comprised nine statements which investigated the ways in which manufacturing SMEs employ 4IR technologies; Section C comprised 10 statements which investigated the benefits that are derived from the adoption of technologies by manufacturing SMEs; Section D comprised 11 statements which investigated the challenges encountered by manufacturing SMEs in the adoption of 4IR technologies; and Section E investigated the strategies used by manufacturing SMEs in KZN to overcome challenges posed by technology implementation. A qualitative segment, which comprised four assertions, was also included.

The closed-ended questions in Sections B to E of the questionnaire were in the form of predefined statements. Participants were asked to select responses to the statements to indicate their views on the technologies available to them, their technical skills, and factors that they regarded as significant to technology adoption. Responses to the statements were rated using a five-point Likert scale on which 1 denoted 'strongly disagree', 2 denoted 'disagree', 3 denoted 'neutral', 4 denoted 'agree', and 5 denoted 'strongly agree'.

5.4 Statistical analysis

A reliability test was conducted for Sections B to E of the questionnaire. Relationships between the variables were tested using cross tabulations.

5.4.1 Cronbach's alpha reliability coefficient

The two most important aspects of precision are reliability and validity. Reliability is calculated by determining the consistency between several measurements taken on the same subject. A reliability coefficient of 0.70 or higher is considered acceptable. Table 5.2 below shows the Cronbach's alpha coefficient for all items in the questionnaire.

Table 5.2: Reliability scores

	Section	Number of Items	Cronbach's Alpha
B	Utilisation of 4IR technologies by manufacturing SMEs in KZN	10	0.782
C	Benefits of the adoption of 4IR technologies by manufacturing SMEs in KZN	10	0.753
D	Barriers to the adoption of 4IR technologies by manufacturing SMEs in KZN	12	0.782
E	Strategies for ICT adoption by manufacturing SMEs in KZN	11	0.824
	All items included	43	0.846

The reliability test was performed on all statements in the questionnaire, which were grouped into four themes in accordance with the research aims. Table 5.2 above indicates that the reliability scores for all sections exceed the recommended Cronbach's alpha value for a newly developed construct. This indicates an acceptable degree of consistency between items in all sections of the questionnaire.

5.4.2 Factor analysis

Factor analysis is a key tool used in the design, modification, and analysis of tests, scales, and measurements; its primary objective is data reduction (Taherdoost, Sahibuddin and Jalaliyoon 2022: 357). Factor analysis is especially beneficial for identifying the factors that underlie the variables by combining similar variables into one component (Shrestha 2021: 4). In this study, factor analysis was used to

determine whether the four variables accurately reflect similarity across all manufacturing sectors. Factor analysis was also used to determine whether the challenges encountered by manufacturing SMEs in technology adoption, such as a lack of digital skills and a lack of ICT infrastructure, affect the successful implementation of technology or the ways in which 4IR technologies are employed, and whether the benefits of adopting 4IR technologies are different for each manufacturing SME as described in Chapter Two.

5.4.3 KMO and Bartlett's test

The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's test indicate the suitability of data for structure detection. The KMO is a statistic that indicates the proportion of variance in the variables that might be caused by underlying factors (Effendi *et al.* 2020: 248). High values (close to 1.0) generally indicate that factor analysis may be useful with the data. If the value is less than 0.50, the results of factor analysis will probably not be very useful (Napitupulu, Kadar and Jati 2017: 700). Bartlett's test of sphericity tests the hypothesis that the correlation matrix is an identity matrix, which would indicate that the variables are unrelated and therefore unsuitable for structure detection (Fathima and Helan 2019: 50). Small values (less than 0.05) of the significance level indicate that factor analysis may be useful with the data.

Table 5.3: Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test

	Section	Kaiser-Meyer-Olkin measure of sampling adequacy	Bartlett's test of sphericity		
			Approx. Chi-Square	Df	Sig.
B	Utilisation of 4IR technologies by manufacturing SMEs in KZN	0.841	529.599	45	< 0.001
C	Benefits of the adoption of 4IR technologies by manufacturing SMEs in KZN	0.730	601.160	45	< 0.001
D	Barriers to the adoption of 4IR technologies by manufacturing SMEs in KZN	0.805	983.058	66	< 0.001
E	Strategies for ICT adoption by manufacturing SMEs in KZN	0.843	843.434	55	< 0.001

Table 5.3 above shows that the conditions for factor analysis are satisfied. These conditions are that the KMO value should be greater than 0.500 and that the Bartlett's test of sphericity sig. value should be less than 0.05. These results clearly indicate that sampling, and all the variables under the categorised themes, are adequate and statistically significant in measuring the same thing. The KMO value for Section E is 0.843, which indicates that strategies for ICT adoption by manufacturing SME's in KZN have a strongly significant impact (0.001) on the ability of manufacturing SMEs to be innovative and to achieve sustainable growth.

5.5 Section A: Demographic data

Section A of the questionnaire relates to the demographic information of the participants in the study. Participants were asked to specify their firm's manufacturing sector, whether or not they were the owner of the firm, their firm's location, the number of years their firm had been in business, their highest educational qualification, their position in the firm, and the size of their firm. This data was collected in order to gain a better understanding of the participants' backgrounds. The responses gathered in this section were essential in demonstrating that knowledgeable participants who could provide the information needed for the study had been selected. The demographic information provided an understanding of categorical barriers to technology adoption by manufacturing SMEs in KZN. Moreover, it provided insight into the influence of aspects such as the number of years a firm had been in operation and the level of education of the owner on SMEs owners' perspectives on technology. Such insight could assist in establishing whether seasoned SMEs owners, who might be familiar only with traditional approaches to manufacturing business operations, had any understanding of embedding technology in their day-to-day operations. In addition, examining differences between the perspectives of experienced and novice owners of manufacturing SMEs could shed new light on the issue of barriers to the adoption of technology by SMEs.

5.5.1 Manufacturing sectors

Table 5.4 and Figure 5.1 below show the frequency and percentage distribution of the manufacturing sectors to which the SMEs in this study belong.

Table 5.4: Manufacturing sectors

	Frequency	Percent
Furniture and fixtures	46	17.6
Textile and clothing	35	13.4
Paper industry	33	12.6
Craft	31	11.9
Automotive	29	11.1
Metal	23	8.8
Household goods	22	8.4
Chemical industry	19	7.3
Pharmaceutical industry	14	5.4
Other	9	3.4
Total	261	100.0

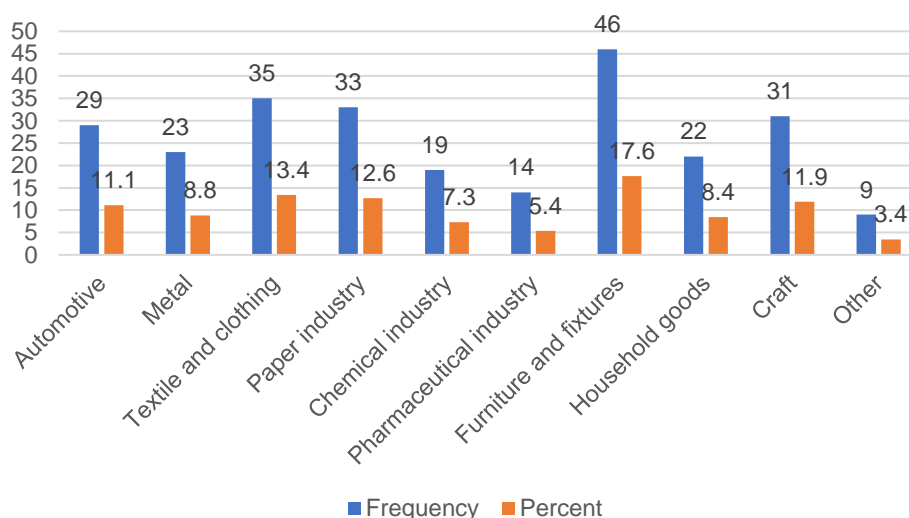


Figure 5.1: Manufacturing sectors

Figure 5.1 above shows significant variations in the numbers of SMEs in different sectors. Many of the SMEs were part of the furniture and fixtures industry, which accounted for a sizeable 17.6% of the entire sample. Other sectors with relatively high representation were the textile and clothing sector (13.4%), the paper industry (12.6%), the craft sector (11.9%), and the automotive industry (11.1%). Only 5.4% of the SMEs studied were in the pharmaceutical sector. A category labelled “Other” accounted for only 3.4% of the total, which was negligible in comparison with the above-mentioned sectors.

These results highlight the diverse range of industries included in the study’s ambit and provide insight into the distribution of firms among various industrial sectors in KZN. As noted in a report by Statistics South Africa (2022b), job creation and the

growth of the province’s economy depend heavily on SMEs involved in sectors such as the food and beverage, metal, automotive, furniture, clothing, and textile industries.

5.5.2 Ownership, managerial and other roles

Figure 5.2 below shows the frequency and percentage distribution of ownership, managerial and other roles of respondents.

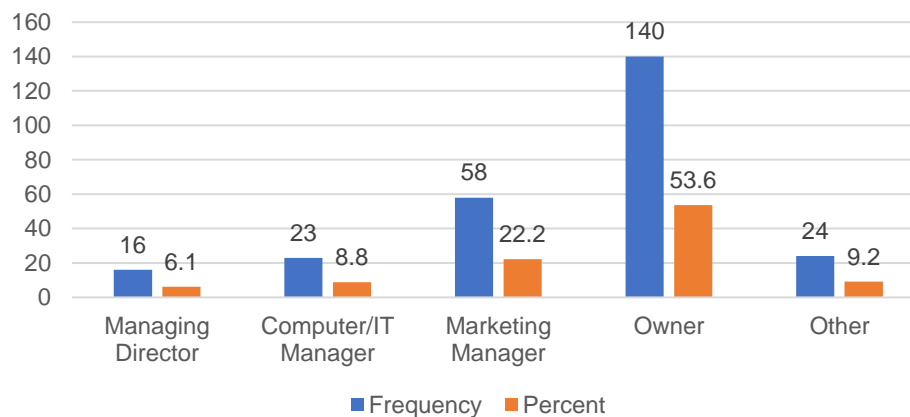


Figure 5.2: Ownership, managerial and other roles

As shown in Figure 5.2 above, 140 respondents, or 53.6% of the total number of participants, were owners of manufacturing SMEs, while 46.4% of the respondents held managerial or other roles. Therefore, there was no significant difference between the proportion of respondents who were owners and the proportion of respondents who were non-owners.

An analysis of these findings suggests that owners are primarily responsible for steering successful and sustainable manufacturing SMEs. In addition to presenting the distribution of the respondents’ ownership and management positions in the manufacturing SMEs in this study, Figure 5.2 above also illustrates the interdependence of ownership, decision-making, and sustainable business practices. In order to develop strategies and regulations that will help manufacturing SMEs thrive in a highly competitive business environment, it is essential to have a comprehensive understanding of the interaction between ownership and management dynamics.

5.5.3 Geographical location

Figure 5.3 below shows the frequency and percentage distribution of the geographical locations of the SMEs that were studied.

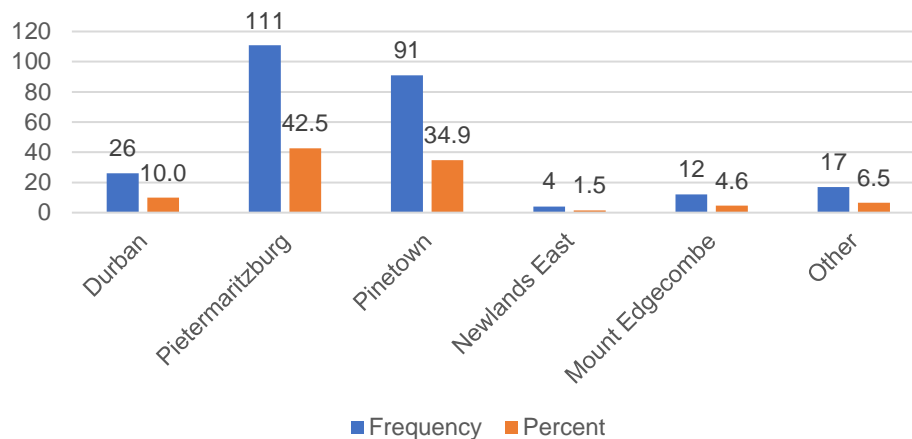


Figure 5.3: Geographical location

As shown in Figure 5.3 above, the highest number of manufacturing SMEs (111 enterprises, or 42.5% of the total) were based in Pietermaritzburg; this was followed by Pinetown, where 91 SMEs, or 34.9% of the entire sample, were located. A further 26 manufacturing SMEs (10%) were located in Durban, while 17 manufacturing SMEs (6.5%) were located in other areas, including Phoenix, Mobeni, Scottburgh, and Dundee. A further 12 manufacturing SMEs (4.6%) were located in Mount Edgecombe, and 4 manufacturing SMEs (1.5%) were located in Newlands East.

In addition to shedding light on the distribution of manufacturing SMEs among geographical regions, an analysis of Figure 5.3 above highlights areas with economic potential and those where government interventions can be beneficial. An understanding of such trends is crucial for the development of effective policies, systematic allocation of resources, and equitable economic growth. Levels of concentration of SMEs demonstrate the significance of particular regions for manufacturing activity, which may be due to availability of infrastructure such as buildings, roads, and businesses, consumer demand for certain items, or commercial relationships. The low concentration level of SMEs in Mount Edgecombe suggests that there is room for further development and expansion in this area. To comprehend the

factors that might give rise to the expansion of new industries, more research is needed into the factors limiting industrial growth in this area. An understanding of the issues faced by enterprises in this area will enable the government to facilitate the growth and development of industries.

5.5.4 Period of operation

Figure 5.4 below shows the percentage distribution of the periods for which the SMEs had been in operation.

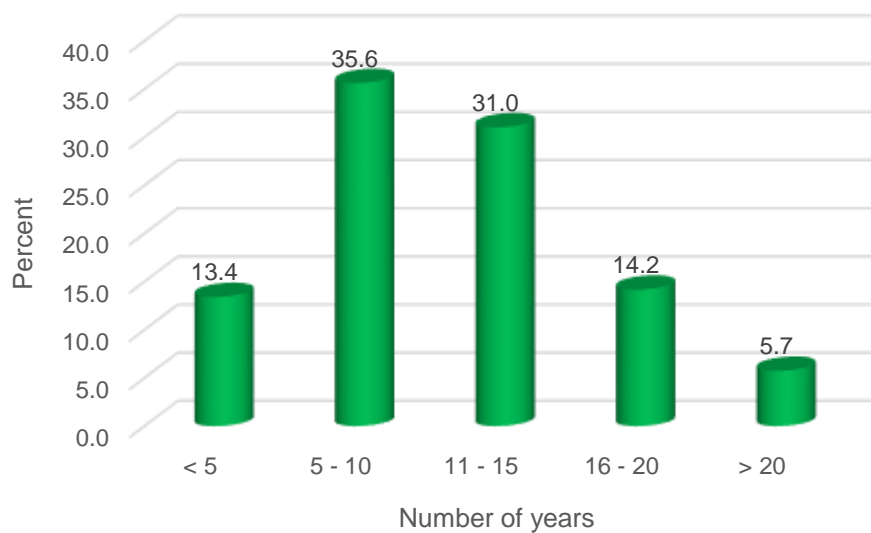


Figure 5.4: Period of operation

As shown in Figure 5.4 above, approximately 87% of the SMEs had been in operation for five or more years. This indicates that most of the data for this study were collected from well-established manufacturing SMEs. Approximately 13.4% of the SMEs had been in operation for less than five years.

It is evident from these findings that some manufacturing SMEs have established their target markets and have strategic plans that are sufficiently productive to sustain their operations. While previous studies have found that the majority of SMEs liquidate before reaching their full potential growth (Cefis *et al.* 2022; Rao *et al.* 2023), such findings also indicate that 19.9% of manufacturing SMEs have managed to sustain their operations. The longevity of SMEs, especially those that survive past the critical

15-year mark, can be attributed to their ability to adapt and innovate, to efficiently manage their resources, and to form sustainable relationships with customers and partners. It also demonstrates their ability to develop effective strategies, financial competency, effective leadership, and internal and external productivity. A nurturing environment can contribute significantly to enhancing the continuous growth of these SMEs.

5.5.5 Highest qualifications obtained by respondents

Figure 5.5 below shows the percentage distribution of the highest qualifications obtained by respondents.

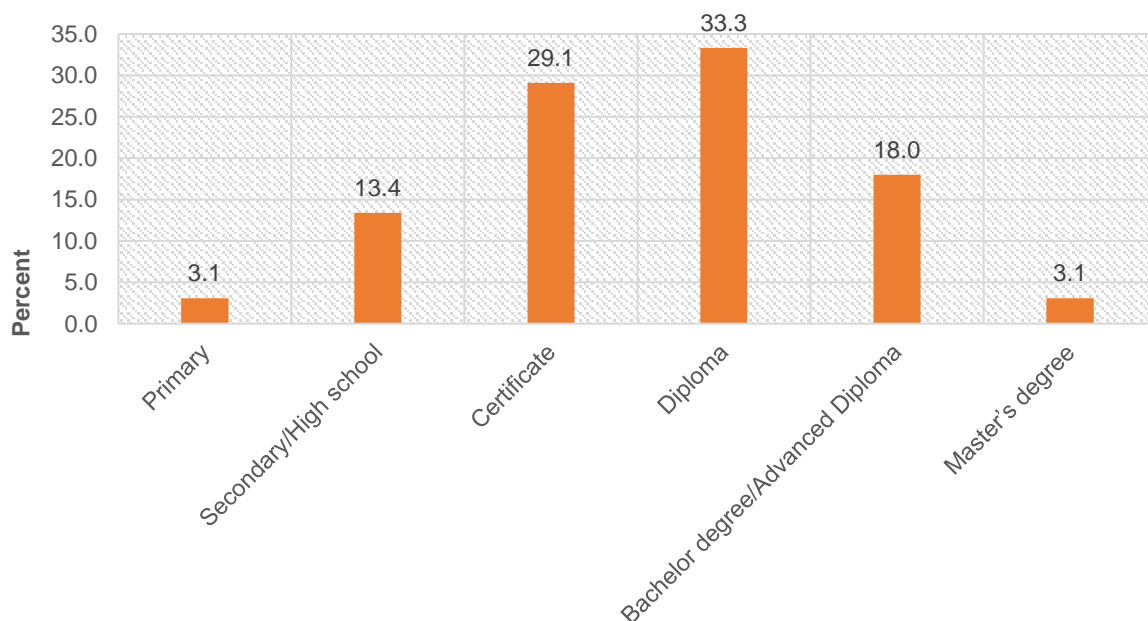


Figure 5.5: Highest qualifications obtained by respondents

As shown in Figure 5.5 above, 83.5% of respondents had obtained post-secondary qualifications, and 21.1% had obtained at least a bachelor's degree, which indicates that a significant number of managers of manufacturing SMEs are highly educated. This not only draws attention to the respondents' academic ability but also highlights a high level of skills and knowledge among respondents. Previous studies have revealed a concerning trend of a lack of academic achievement among those holding positions of authority in manufacturing SMEs (Pillay 2016; Leboea 2017; Tsotsotso *et al.* 2017). However, more recent studies conducted by Kandolo (2023) and Ncube and

Lekhanya (2023) contend that there has been a steady increase in knowledge-based entrepreneurship, which has been demonstrated by a rise in educational levels among SMEs' top executives. This shift reflects the ever-changing dynamics of the entrepreneurial environment and highlights the value of education in fostering innovation, competitiveness, and adaptation among SMEs (Jeza and Lekhanya 2022; Panibon 2023). Studies conducted by Lekhanya (2015: 411) and Spescha and Wörter (2022) found that levels of education had a direct influence on leadership and innovation skills as education enabled a greater awareness of business issues and greater involvement with innovation in a firm. Therefore, the empirical findings of this study concur with those of recent studies.

5.5.6 Current positions of respondents

Figure 5.6 below shows the percentage distribution of the current positions of the respondents in their organisations.

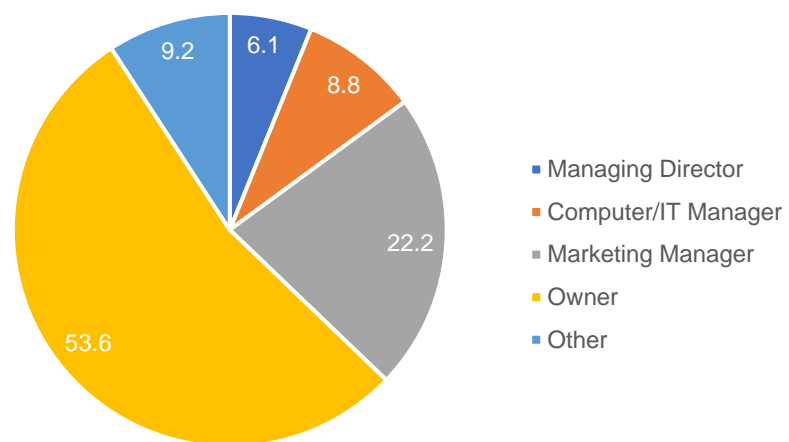


Figure 5.6: Current positions of respondents

As shown in Figure 5.6 above, slightly more than half of the respondents (53.6%) were owners, and 22.2% were marketing managers. Smaller numbers of respondents were IT managers (8.8%) and managing directors (6.1%). 9.2% of the respondents did not hold any of the above-mentioned positions.

Figure 5.6 provides insight into the decision-making process in manufacturing SMEs and the divergent perspectives and obligations held by owners, marketing managers, and managing directors. The essential role of owners, marketing managers, and managing directors of manufacturing SMEs in technology adoption is dependent on their capacity to coordinate their firm's strategic goals, market needs, and operational effectiveness. As a result, their collective efforts have the potential to produce an atmosphere that encourages technology integration, innovation, competitiveness, and sustained development within the SME sector. These findings resonate with those of a study conducted by Nunden *et al.* (2022), which established that there is a clear and significant relationship between decision-making, vision, and vested interest in businesses that are predominantly run by owners.

5.5.7 Firm size

Figure 5.7 below shows the percentage distribution of the size of the SMEs in number of employees.

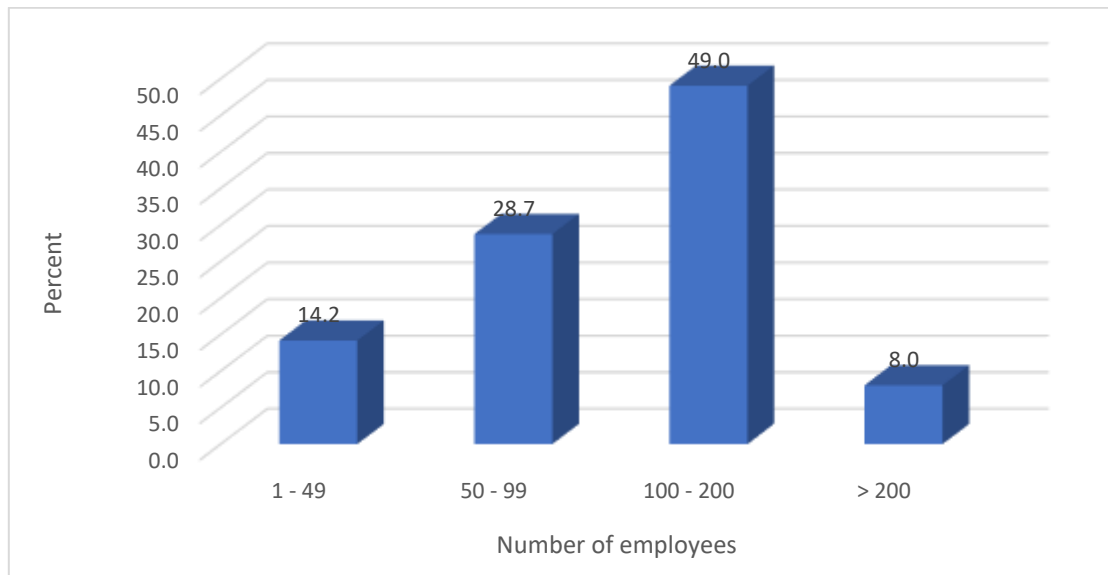


Figure 5.7: Firm size

As shown in Figure 5.7 above, approximately half of the SMEs (49.0%) employed between 100 and 200 people, and 8.0% employed more than 200 people. Approximately 29% of the SMEs employed between 50 and 99 people, and 14.2% had fewer than 50 employees.

An analysis of Figure 5.7 indicates dissimilarity in the number of employees of manufacturing SMEs, which can be attributed to a variety of factors. A study conducted by Krüger, Dickason and Meyer (2020: 6) asserts that some SME owners prefer having fewer employees because they believe that their size influences how rapidly business expertise spreads throughout the firm, and that SMEs are thus able to develop a high level of operational expertise much more quickly than large firms. On the other hand, Kurdi and Alshurideh (2020: 3981) assert that a firm’s need to employ additional staff members is influenced by the stability of its finances and increasing demands that cannot be met by a restricted number of employees.

5.6 Section B: Utilisation of technologies

Section B of the questionnaire aimed to assess the different ways in which manufacturing SMEs employ ICT. In addition to highlighting the transformative influence of technology on the manufacturing industry, an understanding of the diverse applications of ICT in this context provides insight into the ability of SMEs to innovate and adapt.

5.6.1 Creation of new products and services

Figure 5.8 below shows the frequency and percentage distribution of responses to the statement ‘ICTs adopted are used for the creation of new products or services’.

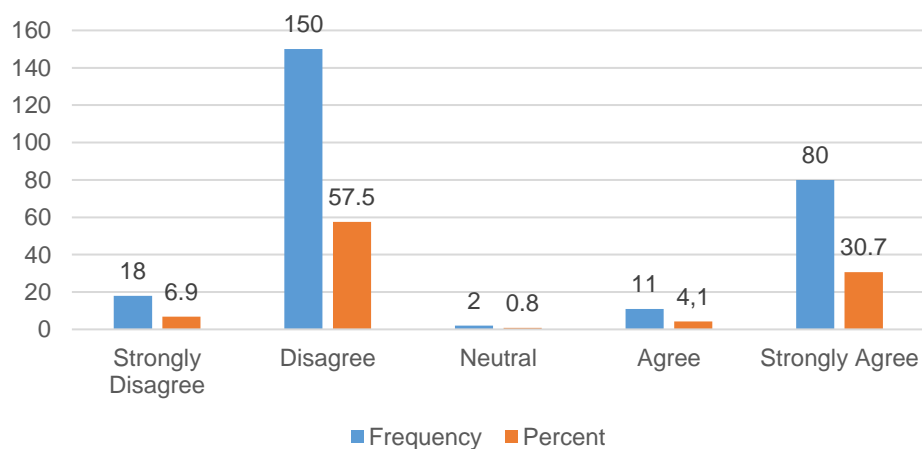


Figure 5.8: Creation of new products and services

As shown in Figure 5.8 above, the majority of respondents disagreed (150 or 57.5%) or strongly disagreed (18 or 6.9%) with this statement. This indicates that the technologies that had been adopted by these SMEs did not enable the creation of products, but were used for other purposes. On the other hand, 80 respondents (30.7%) strongly agreed and 11 (4.1%) agreed that technology was utilised to manufacture products in their organisations. Only 2 respondents (0.8%) expressed a neutral response.

The results of a chi-square test ($X^2 = 301.47$; $df = 4$; $P = 0,001$) indicated that ICTs adopted by manufacturing SMEs had not significantly influenced the creation of products. These results show that the usage and application of technology has been limited among manufacturing SMEs in KZN. The underutilisation of technology by manufacturing SMEs is a clear sign of a lack of digital knowledge within firms, which has been attributed to variables such as the absence of in-house digital experts (Mavimbela and Dube 2016; Rathore 2023).

The effectiveness and sustainability of an organisation is influenced by its ability to implement advanced technologies and to persuade its workforce to accept these changes (Elgohary and Abdelazyz 2020: 2). A study conducted by Tsai *et al.* (2020: 6), which examined the relationship between technology anxiety and resistance to change, highlighted unpredictability and emergent technological errors as factors that lead to reluctance to change. Samhan (2018: 6) argues that factors that contribute to technology anxiety or resistance to change vary from organisation to organisation; such factors, which include low education levels, a lack of prior computer experience, a lack of technological awareness, a lack of perceived usefulness of the technology, and a lack of funding for technology adoption, may lead to non-adoption of technologies.

5.6.2 Provision of timely and accurate information for decision making

Figure 5.9 below shows the frequency and percentage distribution of responses to the statement '4IR technologies are utilised to provide more timely and accurate information for decision making'.

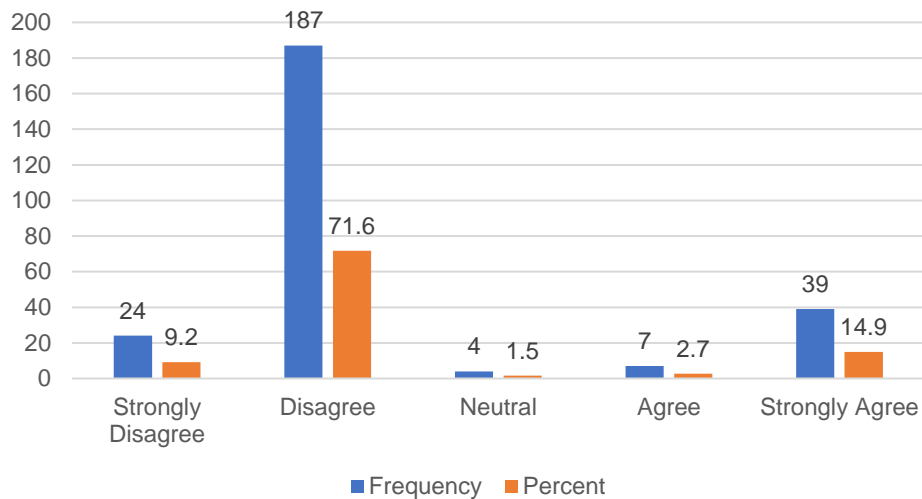


Figure 5.9: Provision of timely and accurate information for decision making

As shown in Figure 5.9 above, the majority of respondents (80.8%) either disagreed or strongly disagreed with the above statement. This suggests that most manufacturing SMEs prefer to use traditional methods for business operations and have been somewhat reluctant to adopt technology. On the other hand, 17.6% of the respondents indicated that they were open to adopting 4IR technologies and acknowledged the benefits that resulted from doing so.

The results of a chi-square test ($X^2 = 450.322$; $df = 4$; $P = 0,001$) showed that these findings were significant. This suggests that 4IR technologies have made very little contribution to providing information for decision making in SMEs.

According to Faheem *et al.* (2018: 6), the primary goal of ICT is to provide a highly dependable and adaptable communication system and establish guidelines to enable real-time interactions between businesses and consumers in the smart grid. Technology can provide owners of SMEs with a powerful tool to gather information from a virtual illustration of the business for decision-making purposes (Gao and Pishdad-Bozorgi 2019: 227). Despite widespread acknowledgement of the ability of ICTs to provide quick and dependable information to aid decision-making, the findings of studies conducted by Zhou (2021) and Zwane and Zhou (2023) reflect concerns with regard to deficiencies in the knowledge and skills possessed by manufacturing SMEs with regard to using technologies to improve decision making. In addition, many manufacturing SMEs appear not to be up to date with the latest technologies.

5.6.3 Access to global markets

Figure 5.10 below shows the frequency and percentage distribution of responses to the statement '4IR technologies enable my firm to trade globally'.

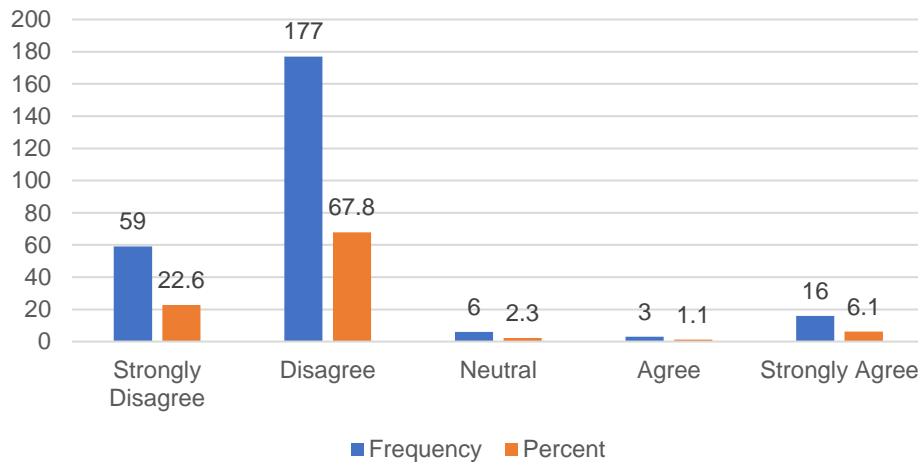


Figure 5.10: Access to global markets

As shown in Figure 5.10, the majority of respondents (177 or 67.8%) disagreed and a further 59 (22.6%) strongly disagreed that 4IR technologies had enabled their organisations to trade globally. On the other hand, 16 respondents (6.1%) strongly agreed and 3 (1.1%) agreed with this statement. Only 6 respondents (2.3%) expressed a neutral response.

A chi-square test was conducted to determine whether 4IR technologies had enabled manufacturing SMEs to trade on a global scale. The results of this test ($X^2 = 411,625$; $df = 4$; $P = 0,001$) indicated that 4IR technologies had not enabled firms to trade globally. This could be due to non-compliance of the 4IR solutions implemented by these firms with international standards and regulations. As noted by Madhav and Tyagi (2022), some technologies that function effectively in local settings may be difficult to incorporate into global platforms due to compatibility issues or differentiated international standards. Denicolai, Zucchella and Magnani (2021: 1) assert that the conventional SME strategy, which has been characterised by a relatively small

geographic range (typically the local market), a lack of digital innovation, and a lack of environmental consciousness, is no longer workable.

5.6.4 Competitive advantage

Figure 5.11 below shows the frequency and percentage distribution of responses to the statement ‘ICT enhances competitive advantage’.

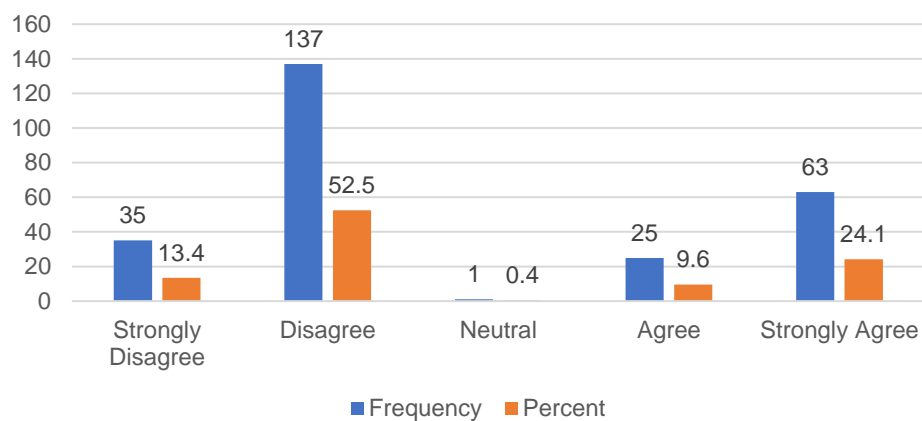


Figure 5.11: Competitive advantage

As shown in Figure 5.11 above, the majority of respondents (172 or 65.9%) either disagreed or strongly disagreed with this statement. This could be due to a lack of the necessary capacity in manufacturing SMEs to establish and maintain competitive advantage using ICT. On the other hand, 63 respondents (24.1%) strongly agreed and 25 respondents (9.6%) agreed that ICT had improved their firm’s competitive advantage. Only 1 respondent (0.4%) expressed a neutral response.

The results of a chi-square test ($X^2 = 210.054$; $df = 4$; $P = 0,000$) showed that these findings were significant, which indicates that ICT had not enhanced competitive advantage. These findings contradict those of a study by Francke and Alexander (2019), who found that ICT as a sustainable development strategy can help enhance SME competitiveness in a variety of ways. Kamau *et al.* (2019: 3) assert that IT enhances managerial and operational capabilities in business systems, which aids firms in gaining a competitive advantage through better customer connection. By leveraging ICT, SMEs can also monitor their performance more effectively and

respond quickly to changes in the marketplace (Bag *et al.* 2022). However, the empirical findings of this study reflect that a lack of awareness and a lack of robust adoption of emerging technologies prevent manufacturing SMEs from reaping the benefits of ICT.

5.6.5 Support of business processes

Figure 5.12 below shows the frequency and percentage distribution of responses to the statement 'ICT is used to support business activities such as research and development, distribution, and sales and feedback'.

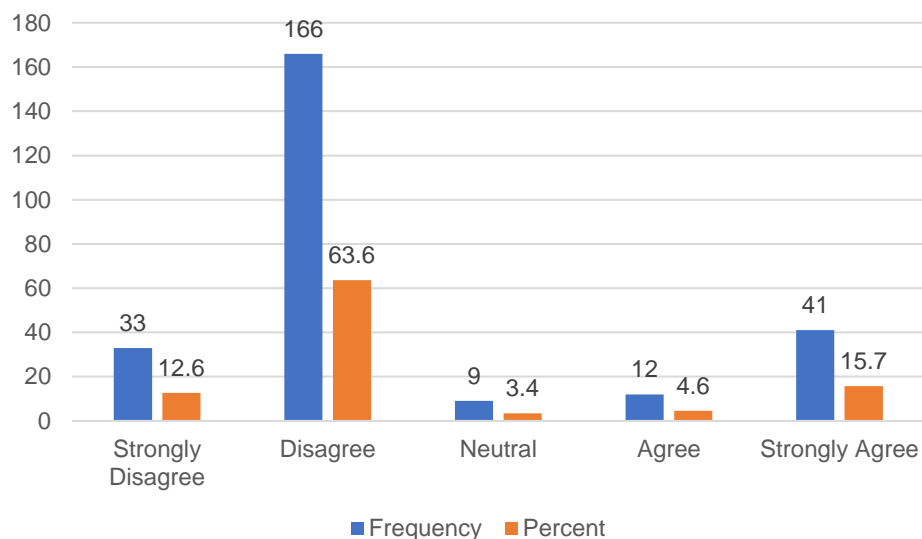


Figure 5.12: Support of business processes

As shown in Figure 5.12 above, the vast majority (nearly 80%) of respondents either disagreed (166 or 63.6%) or strongly disagreed (33 or 12.6%) that ICT was used to support business activities in their firms. On the other hand, 41 respondents (15.7%) strongly agreed and 12 (4.6%) agreed with this statement, while only 9 respondents (3.4%) expressed a neutral response.

These findings could be an indication that established firms are more likely than SMEs to conduct research into customer needs and to prioritise customer feedback as a tool to improve their services. Differences in technological functionality amongst manufacturing SMEs can be attributed to various reasons, including levels of

education and experience, differences in operational priorities, and variances in technology needs and customer requirements (Cirera, Comin and Cruz 2022). Valuable data, feedback, monitoring of conditions, and collaboration with suppliers all enable SMEs to achieve their objectives, constantly adapt, and exceed customer expectations (Dutta *et al.* 2021: 1680).

A chi-square test was conducted to determine whether the use of ICT by SMEs supported business activities such as research and development, distribution, and sales and feedback. The results of this test ($X^2 = 324.268$; $df = 4$; $P = 0,001$) indicated that a significant number of managers of manufacturing SMEs believed that the technologies implemented in their organisations did not support research and development. This may be due to challenges encountered by SMEs in utilising advanced technologies with user interfaces that are overly complicated and difficult to understand for research purposes. As noted by Nkosana (2022), the complexity of a technology's interface can discourage SMEs from effectively utilising the technology for research and development.

5.6.6 Integration and connectivity of enterprise applications

Figure 5.13 below shows the frequency and percentage distribution of responses to the statement 'The chosen technologies allow for integration and connectivity of applications and expedite the day-to-day functions of the enterprise'.

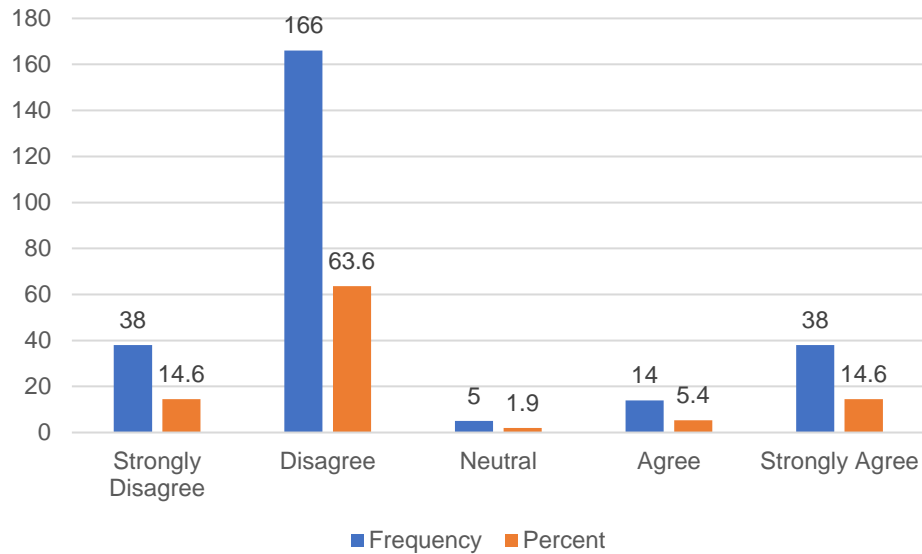


Figure 5.13: Integration and connectivity of enterprise applications

As shown in Figure 5.13 above, the majority of respondents (166 or 63.6%) disagreed and 38 (14.6%) strongly disagreed that the technologies used in their firms allowed for the integration and connectivity of applications. On the other hand, 38 (14.6%) strongly agreed and 14 (5.4%) agreed with the statement. Only 5 respondents (1.9%) expressed a neutral response.

These findings indicate that SMEs have diverse opinions and experiences regarding the effectiveness of the technologies used in their firms in integrating and connecting with other components. Respondents who strongly agreed or agreed with the statement might have experienced instances when the compatibility of a technology with other elements proved highly effective in expediting their firm's operations. An analysis of these findings highlights the importance of understanding divergent perspectives in order to identify opportunities for improvement in addressing the needs of technology users in manufacturing SMEs.

The results of a chi-square test ($X^2 = 326.452$; $df = 4$; $P = 0,001$) showed that these findings were significant, which suggests that the technologies adopted by these firms did not allow for the integration and connection of applications. These findings may be attributed to the advancement of technology, which may render technologies already adopted by a firm obsolete (Breidbach *et al.* 2018: 11). However, Boonsiritomachai, McGrathand and Burgess (2016: 5) argue that when technologies are correctly

implemented by manufacturing SMEs, they do enhance the daily operations of such firms.

5.6.7 Support of business innovation and sustainability

Figure 5.14 below shows the frequency and percentage distribution of responses to the statement ‘The adopted technologies support business innovation and sustainability’.

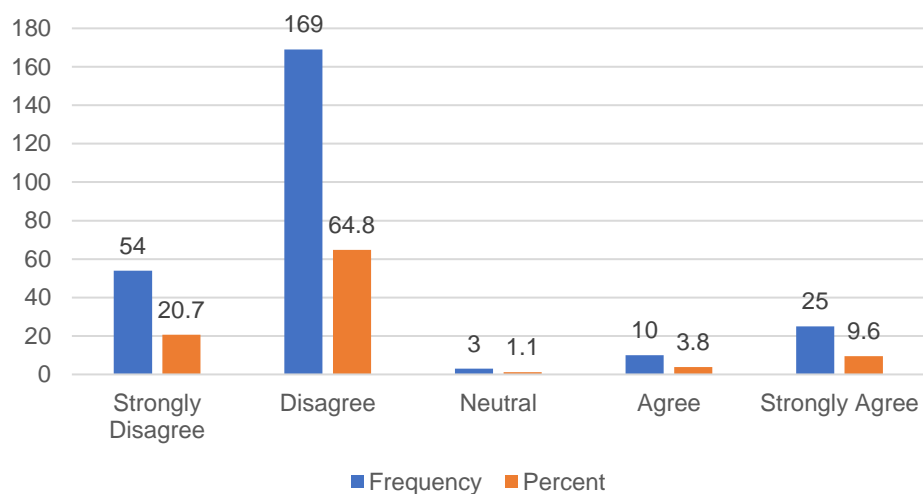


Figure 5.14: Support of business innovation and sustainability

As shown in Figure 5.14 above, the majority of respondents (169 or 64.8%) disagreed and 54 (20.7%) strongly disagreed that the technologies used by their firm supported the firm’s innovation and sustainability. On the other hand, 25 respondents (9.6%) strongly agreed and 10 (3.8%) agreed with this statement, while 3 (1.1%) expressed a neutral response.

The results of a chi-square test ($X^2 = 356.069$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that the 4IR technologies implemented by manufacturing SMEs had not promoted the growth and future viability of the manufacturing sector. These findings could be attributed to the use of only basic technologies for communication purposes by some SMEs. While Chesbrough and Tucci (2020: 5) assert that with the advancement of technology, manufacturers are eager to introduce various innovations as well as to test out novel ideas on the market,

Msomi, Ngibe and Bingwa (2020) note that technologies utilised by a firm could hinder the firm’s ability to expand and generate profits if the technologies are not aligned with the firm’s overall business plan and objectives.

5.6.8 Satisfaction of customer needs

Figure 5.15 below shows the frequency and percentage distribution of responses to the statement ‘The adopted technologies are a key driver in meeting customer needs’.

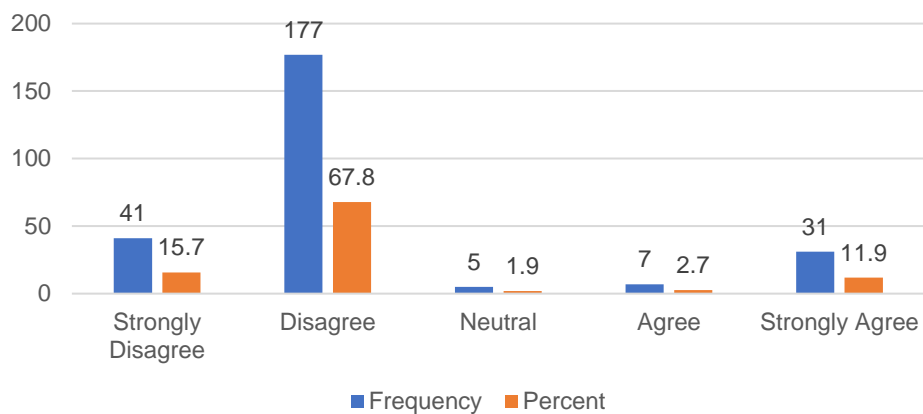


Figure 5.15: Satisfaction of customer needs

Figure 5.15 above shows that the majority of respondents (177 or 67.8%) disagreed and 41 (15.7%) strongly disagreed that the technologies adopted by their firms were a key driver in meeting customer needs. On the other hand, 31 respondents (11.9%) strongly agreed and 7 (2.7%) agreed with this statement. Only 5 respondents (1.9%) expressed a neutral response.

The results of a chi-square test ($X^2 = 391$; $df = 4$; $P = 0,000$) indicated that the technologies adopted by manufacturing SMEs had failed to establish themselves as key drivers in meeting customer needs.

The empirical findings establish a clear pattern that shows that the technologies adopted by manufacturing SMEs appear to be improperly utilised or inadequately adopted to suit the unique operations of these firms. Bayo (2019: 100) highlights the

importance of understanding the reasons motivating the adoption of new technologies before implementing them. Manufacturing SMEs use a variety of technologies to complete their numerous tasks; among these tasks is interaction with customers to understand their needs, which helps SMEs to define their organisational goals (Casalino *et al.* 2019). Studies conducted by Goga, Paelo and Nyamwena (2019), Kampani and Jhamb (2020), and Rajagopaul *et al.* (2020) advocate that ICT can be used to create a more efficient customer service system using automated chat bots, online ordering systems, and customer relationship management software.

5.6.9 Access to financial services

Figure 5.16 below shows the frequency and percentage distribution of responses to the statement ‘ICT is used to facilitate access to a wide range of financial services, thereby increasing efficiency and reducing costs’.

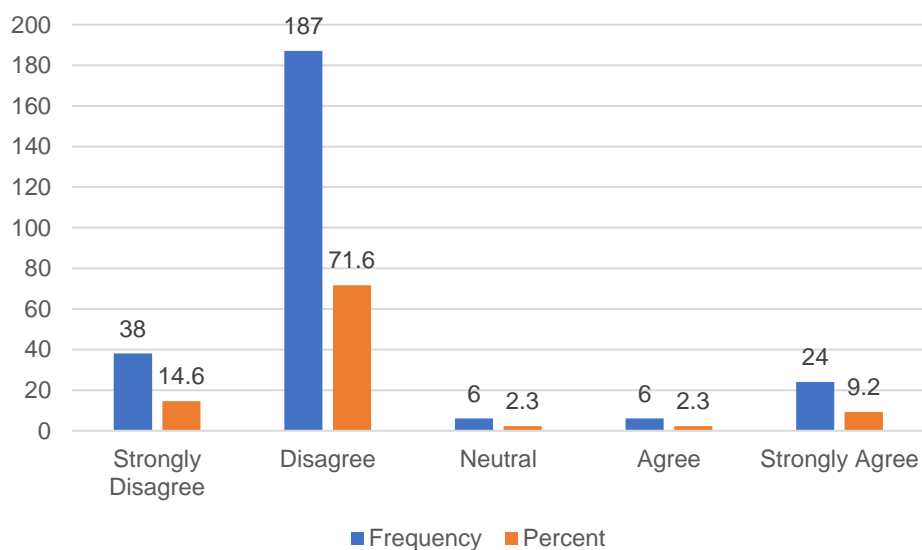


Figure 5.16: Access to financial services

As shown in Figure 5.16 above, the majority of respondents (187 or 71.6%) disagreed and 38 (14.6%) strongly disagreed that ICT was used by their firms to facilitate access to a wide range of financial services, thereby increasing efficiency and reducing costs. On the other hand, 24 respondents (9.2%) strongly agreed and 6 (2.3%) agreed with this statement. A further 6 respondents (2.3%) expressed a neutral response.

A chi-square test was conducted to determine whether ICT was used to facilitate access to a wide range of financial services, thereby increasing efficiency and reducing costs. The results of this test ($X^2 = 448.981$; $df = 4$; $P = 0,001$) showed that these findings were significant; this indicates that there is a correlation between technology adoption by manufacturing SMEs and the efficiency of these firms, which affects their ability to reduce costs. Kumar and Ayedee (2021: 8) assert that the adoption of technology enables manufacturing SMEs to increase their efficiency and profitability.

5.6.10 Elimination of repetitive tasks

Figure 5.17 below shows the frequency and percentage distribution of responses to the statement '4IR technologies are used to enhance the firm's efficiency by eliminating repetitive tasks'.

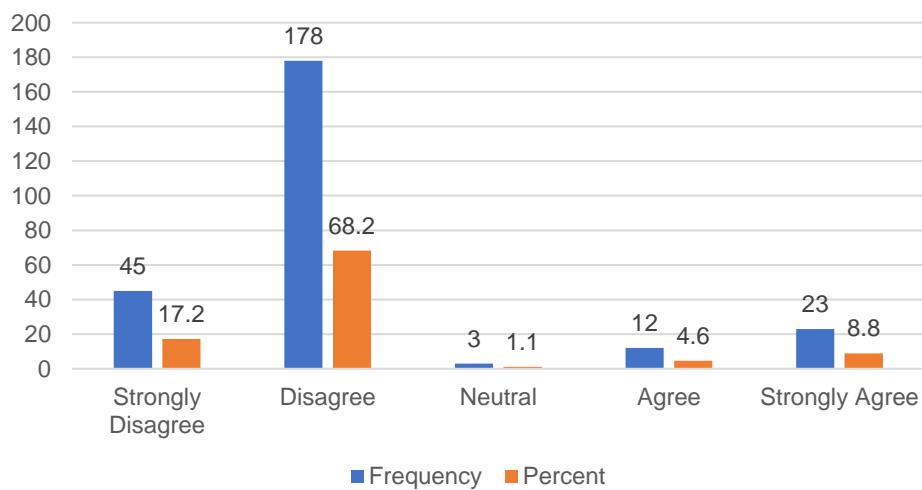


Figure 5.17: Elimination of repetitive tasks

As shown in Figure 5.17 above, the majority of respondents (178 or 68.2%) disagreed and 45 (17.2%) strongly disagreed that 4IR innovations had enhanced the efficiency of their firms by eliminating repetitive tasks. On the other hand, 23 respondents (8.8%) strongly agreed and 12 (4.6%) agreed with this statement. Only 3 respondents (1.1%) expressed a neutral response.

The results of a chi-square test ($X^2 = 397.831$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that the 4IR technologies adopted by manufacturing SMEs had no correlation with the efficiency of these firms and the elimination of repetitive tasks.

Han and Trimi (2022) assert that certain SMEs, particularly those with financial resources, have been able to implement recent technological advances that may enable the elimination of repetitive tasks, depending on the type of technology that is used. However, some manufacturing SMEs still use manual labour for such tasks, which has negatively impacted on their productivity and their ability to reach set targets (Adam and Alarifi 2021: 2).

5.6.11 Principal component analysis

The component matrix shown in Table 5.5 below further illuminates the utilisation of 4IR technologies by manufacturing SMEs in KZN.

Table 5.5: Component matrix: Utilisation of technologies

Rotated Component Matrix^a

Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization. a. Rotation converged in 3 iterations

B	Component	
	1	2
ICTs adopted are used for the creation of new products/services	0,068	0,627
4IR technologies are utilised to provide more timely and accurate information for decision making	0,298	0,547
4IR technologies enable my firm to trade globally	0,722	-0,143
ICT enhances competitive advantage	0,001	0,759
ICT is used to support business activities such as research and development, distribution, and sales and feedback	0,386	0,440
The chosen technologies allow for integration and connection of applications and expedite the day-to-day functions of the enterprise	0,569	0,367
The adopted technologies support business innovation and sustainability	0,641	0,212
The adopted technologies are a key driver in meeting customer needs	0,360	0,567
ICT is used to facilitate access to a wide range of financial services, thereby increasing efficiency and reducing costs	0,639	0,205
4IR technologies are used to enhance the firm's efficiency by eliminating repetitive tasks	0,702	0,319

A component test was conducted on the variables that measured the ways in which 4IR technologies are utilised by manufacturing SMEs. The component matrix shows

a statistical analysis of the data presented in Figures 5.8 to 5.17 above. Two components were identified, and significant correlations were found in both components.

The results obtained from the component matrix appear to contradict the findings of previous studies that have shown that ICTs are widely used in manufacturing enterprises. A significant correlation of the variable 'ICTs adopted are used for the creation of new products or services' was found with component 2 (0.627). This suggests that although ICTs can be effective tools, their benefits to manufacturing are yet to be recognised by most manufacturing enterprises, especially in developing countries such as South Africa where the adoption of digitalisation is still sporadic. This can be attributed to a variety of factors including resistance to adopting new business methods, which is influenced by the age and geographical location of a firm. While previous studies have asserted that ICT adoption enhances the competitiveness of SMEs, the empirical findings of this study contradict this assertion. It is evident from the above findings that there are various aspects to consider when examining the relationship between the adoption of ICT and the competitiveness of SMEs, and that technology adoption does not inherently result in competitive advantage. The essential aspect lies in how effectively and strategically technologies are employed and assimilated into an SME's business strategies.

A significant correlation of the variable '4IR technologies are utilised to provide more timely and accurate information for decision making' was found with component 2 (0.547) and a significant correlation of the variable '4IR technologies enable my firm to efficiently trade globally' was found with component 1 (0.722). This suggests that when successfully integrated, the ability of technology to provide timely and accurate information enables manufacturing SMEs to trade globally. No significant correlation of the variable 'ICT is used to support business activities such as research and development, distribution, and sales and feedback' with either component was found.

5.7 Section C: Benefits of the adoption of technologies

Embracing revolutionary technologies serves as a compass for advancement that points SMEs towards the centre of the digital era. In addition, the ability to embrace

technologies demonstrates SMEs' flexibility and forward-thinking mentality. It denotes a readiness to renounce traditional practices and to venture into unexplored territory while utilising innovation to tackle challenging issues. Section C of the questionnaire investigated the various benefits that SMEs experience when they integrate technology into their manufacturing operations.

5.7.1 Competitiveness and improved financial performance

Figure 5.18 below shows the frequency and percentage distribution of responses to the statement '4IR technologies enable manufacturing SMEs to respond to pressure to remain competitive and improve their economic potential'.

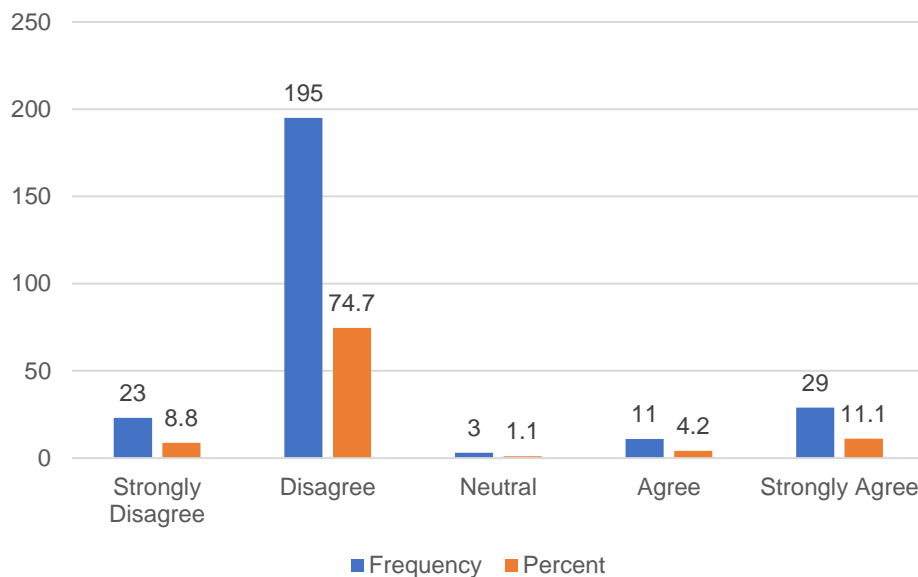


Figure 5.18: Competitiveness and improved financial performance

As shown in Figure 5.18 above, a total of 83.5% of respondents either disagreed (195 or 74.7%) or strongly disagreed (23 or 8.8%) that 4IR technologies had enabled their firms to respond to pressure to remain competitive and had improved their economic potential. On the other hand, 29 respondents (11.1%) strongly agreed and 11 (4.2%) agreed with this statement. Only 3 respondents (1.1%) expressed a neutral response.

The above findings can be attributed to a lack of innovation capability, which is much more prevalent in SMEs than in larger and more established firms (Heenkenda *et al.*

2022: 2). A chi-square test was carried out to ascertain whether there was a significant link between the success of SMEs and the adoption of 4IR technologies. The results of this test ($X^2 = 496.184$; $df = 4$; $P = 0,001$) did not indicate a significant link between SME success and the adoption of 4IR technologies. These findings suggest scepticism regarding the actual impact of the technologies adopted by manufacturing SMEs on their competitiveness and economic growth. This highlights a need for a thorough examination of the obstacles hindering SMEs from reaping the benefits of 4IR technologies (Nkosana 2022).

5.7.2 Efficiency and versatility

Figure 5.19 below shows the frequency and percentage distribution of responses to the statement 'Technology provides greater efficiency and versatility for manufacturing SMEs'.

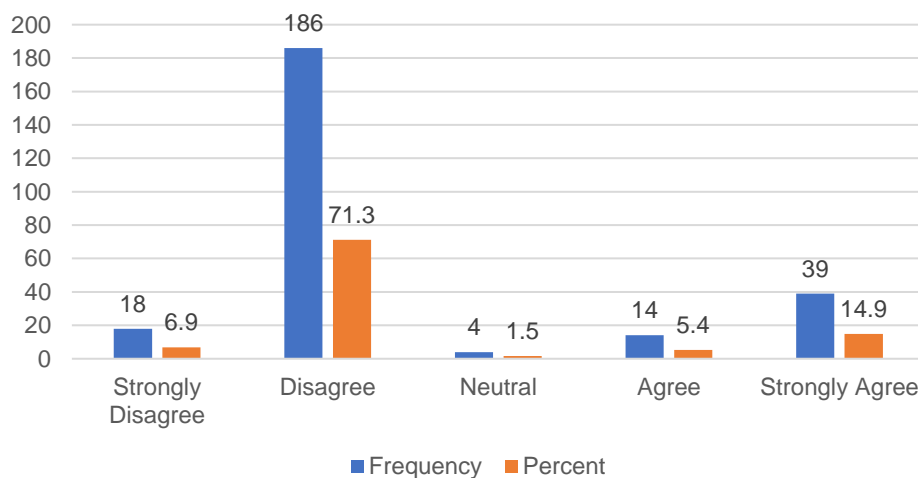


Figure 5.19: Efficiency and versatility

As shown in Figure 5.19 above, a total of 78.2% of respondents either disagreed (186 or 71.3%) or strongly disagreed (18 or 6.9%) that technology had provided greater efficiency and versatility for their firms. On the other hand, 39 respondents (14.9%) strongly agreed and 14 (5.4%) agreed with this statement. Only 4 respondents (1.5%) expressed a neutral response.

Onu and Mbohwa (2021) assert that technology adoption decisions in manufacturing SMEs are driven by expectations for faster delivery times, more efficient processes, greater quality, and customised goods. A chi-square test was conducted to determine whether the technologies adopted by manufacturing SMEs had provided them with greater efficiency and versatility. The results of this test ($X^2 = 441.165$; $df = 4$; $P = 0,001$) indicated that manufacturing SMEs in KZN appear to disagree that there is a correlation between their sustainability and the ability of technologies to provide greater efficiency and versatility. This could be due to the inability of the technologies adopted by these SMEs to provide the benefits mentioned above.

5.7.3 Streamlining of manufacturing workflows

Figure 5.20 below shows the frequency and percentage distribution of responses to the statement '4IR technologies enable manufacturing SMEs to better streamline workflows by tracking time taken in the manufacturing process'.

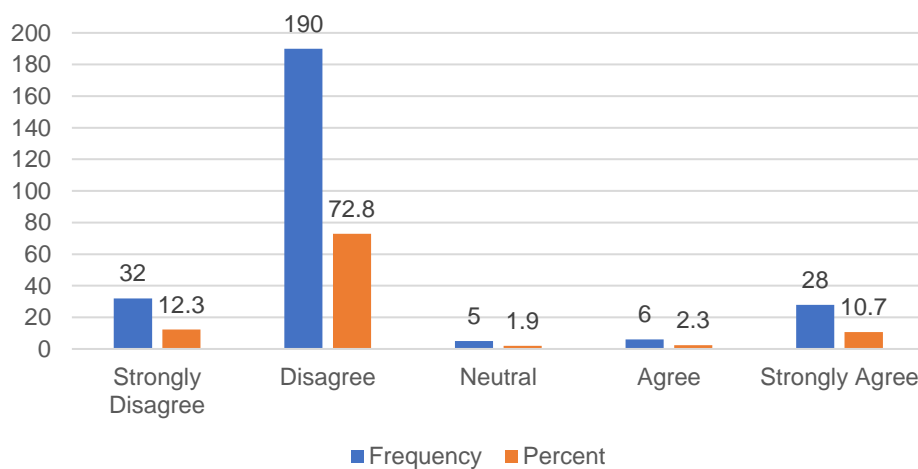


Figure 5.20: Streamlining of manufacturing workflows

As shown in Figure 5.20 above, the majority of respondents (190 or 72.8%) disagreed and 32 (12.3%) strongly disagreed that 4IR technologies had enabled their firms to better streamline workflows by tracking time taken in the manufacturing process. On the other hand, 28 respondents (10.7%) strongly agreed and 6 (2.3%) agreed with this statement. Only 5 respondents (2.3%) expressed a neutral response.

A study conducted by Wong and Kee (2022) asserts that the ability of manufacturing SMEs to track production processes indicates their successful implementation of technology. However, very few of the manufacturing SMEs in this study indicated that the technologies adopted by their firms had enabled them to keep track of manufacturing activities. The results of a chi-square test ($X^2 = 466.375$; $df = 4$; $P = 0,001$) indicated that the 4IR technologies adopted by manufacturing SMEs had failed to streamline workflows by tracking time taken in the manufacturing process. These results have significant ramifications and point to a discrepancy between the claimed benefits of 4IR technologies and their actual application in the context of manufacturing SMEs.

5.7.4 Increased collaboration across different marketing channels

Figure 5.21 below shows the frequency and percentage distribution of responses to the statement ‘The adopted technologies allow manufacturing SMEs to increase collaboration across different marketing channels’.

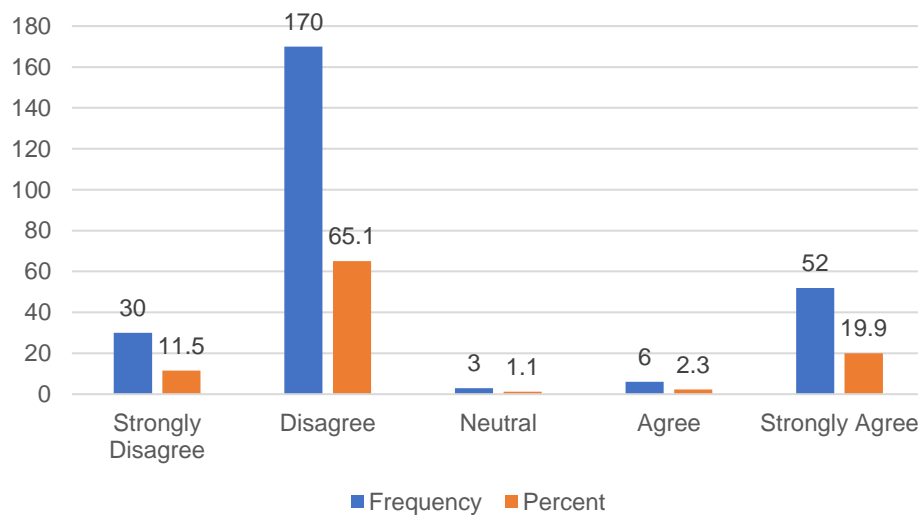


Figure 5.21: Increased collaboration across different marketing channels

As shown in Figure 5.21 above, a total of 76.6% of respondents either disagreed (170 or 65.1%) or strongly disagreed (30 or 11.5%) that the technologies adopted by their firms had enabled them to increase collaboration across different marketing channels.

On the other hand, 6 respondents (2.3%) agreed and 52 (19.9%) strongly agreed with this statement. Only 3 respondents (1.1%) expressed a neutral response.

The above findings indicate differences among manufacturing SMEs with regard to their ability to creatively use technology to enhance their sustainability through collaborative marketing. A chi-square test was conducted to determine whether the technologies adopted by manufacturing SMEs had enabled them to increase collaboration across different marketing channels. The results of this test were significant ($X^2 = 362.544$; $df = 4$; $P = 0,001$), which showed that a sizeable majority of manufacturing SMEs did not possess technologies that enhanced their collaboration with other firms. Studies conducted by Ndulu, Ngwenya and Setlhalogile (2022) and Lubinga, Maramura and Masiya (2023) have found that manufacturing SMEs in South Africa have tended to adopt technology more slowly than their larger counterparts.

5.7.5 Improved communication among employees and with customers

Figure 5.22 below shows the frequency and percentage distribution of responses to the statement ‘When appropriately integrated, technology can improve relationships by making it easier for employees and customers to communicate’.

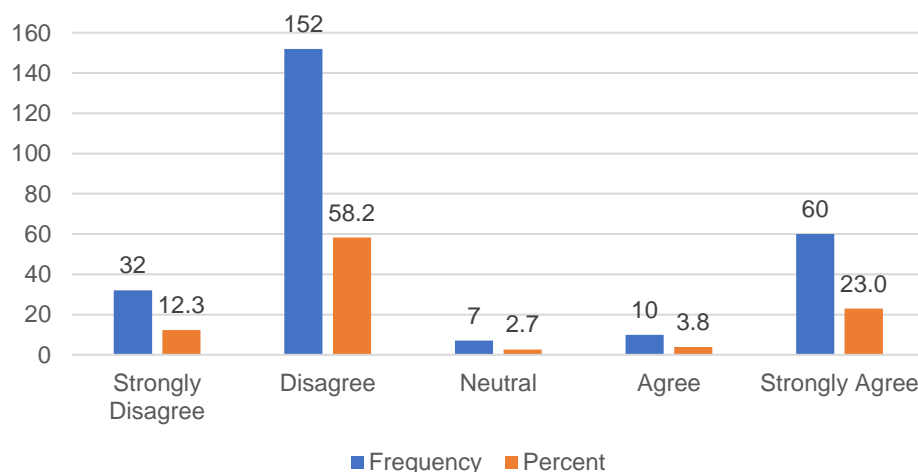


Figure 5.22: Improved communication among employees and with customers

As shown in Figure 5.22 above, the majority of respondents (152 or 58.2%) disagreed and a further 32 (12.3%) strongly disagreed that the technologies adopted by their

firms had improved relationships by making it easier for employees and customers to communicate. On the other hand, 60 respondents (23.0%) strongly agreed and 10 (3.8%) agreed that the technologies adopted by their firms had enhanced communication amongst co-workers. Only 7 respondents (2.7%) expressed a neutral response.

The above findings indicate differences among manufacturing SMEs with regard to whether technology enhances communication in their firms, which can be attributed to the adoption of varying technologies by each manufacturer. The results of a chi-square test ($X^2 = 273.042$; $df = 4$; $P = 0,001$) showed that these findings were significant, which suggests that the utilisation of technology in SMEs did not inherently enhance communication between employees and with customers. On the other hand, the agreement of 26.8% of respondents with this statement suggests that these SMEs have embraced ICT strategically and indicates an essential shift in their practices and strategies. Due to their awareness of the link between their sustainability and technological integration, these SMEs may be more open to using technology for other purposes in addition to enhancing communication. Lukonga (2020) asserts that enabling employees to work more quickly and effectively is a key benefit of technology for SMEs. Manufacturing SMEs that use traditional methods should guard against the inability to develop new strategies for acquiring clients and find innovative ways to enhance customer experience (Bagale *et al.* 2021: 9).

5.7.6 Automation of sales processes

Figure 5.23 below shows the frequency and percentage distribution of responses to the statement 'ICTs facilitate the selective automation of processes related to supporting the field sales force and integrating sales activity into the company's information structure'.

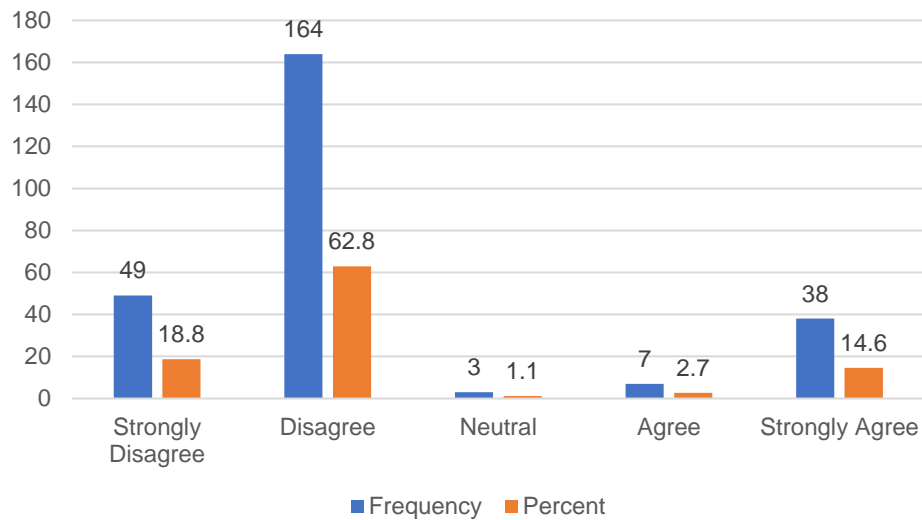


Figure 5.23: Automation of sales processes

As shown in Figure 5.23 above, the majority of respondents (164 or 62.8%) disagreed and a further 49 (18.8%) strongly disagreed that ICT had facilitated the selective automation of processes related to supporting their field sales force and integrating sales activity into their firm's information structure. On the other hand, 38 respondents (14.6%) strongly agreed and 7 (2.7%) agreed with this statement. Only 3 respondents (1.1%) remained neutral.

The results of a chi-square test ($X^2 = 329.019$; $df = 4$; $P = 0,001$) showed that these findings were significant, which suggests that there was no correlation between the adoption of technology by manufacturing SMEs and their ability to support their field sales force and integrate sales activity into their information structure. These findings indicate that it is crucial to precisely coordinate the integration of technology with particular business needs and goals.

5.7.7 Gathering of marketing information

Figure 5.24 below shows the frequency and percentage distribution of responses to the statement 'The adopted technologies enable SMEs to facilitate the gathering of valuable competitive knowledge and consumer-related information that simplifies marketing decision processes'.

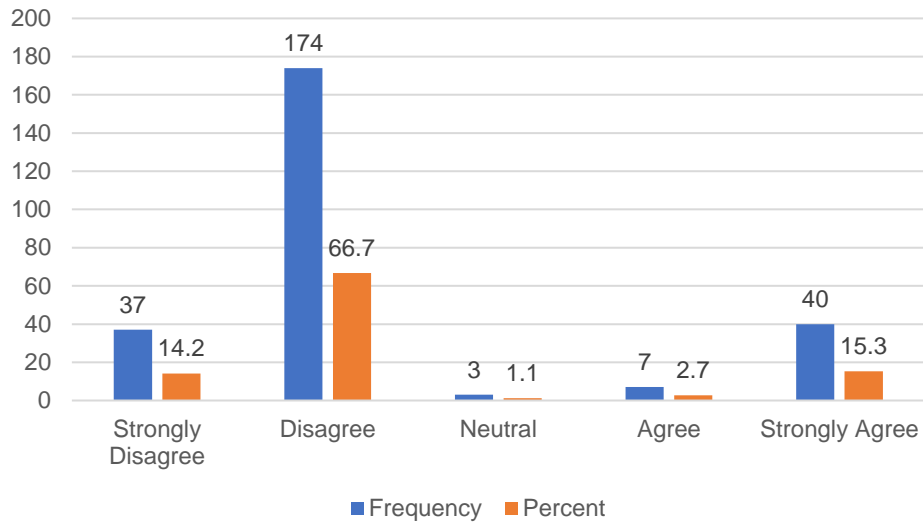


Figure 5.24: Gathering of marketing information

As shown in Figure 5.24 above, 80.9% of respondents either disagreed (174 or 66.7%) or strongly disagreed (37 or 14.2%) that the technologies adopted by their firms had enabled them to facilitate the gathering of valuable competitive knowledge and consumer-related information that had simplified their marketing decision processes. On the other hand, 40 respondents (15.3%) strongly agreed and 7 (2.7%) agreed with this statement. Only 3 respondents (1.1%) expressed a neutral response.

A chi-square test was conducted to determine whether the technologies adopted by SMEs had enabled them to facilitate the gathering of valuable competitive knowledge and consumer-related information that had simplified their marketing decision processes. The results of this test ($X^2 = 376.989$; $df = 4$; $P = 0,001$) indicated that these findings were insignificant as the majority of the manufacturing SMEs disagreed with the above statement.

According to Dlodlo and Mafini (2014: 48), technology makes it feasible for manufacturing SMEs to communicate with clients and competitors and to gather data about them in a highly economical way. With flexible competition policies that adapt easily to new situations and benefit from experiential learning, technology enables SMEs to stay ahead of their competitors (Tirole 2020: 5).

5.7.8 Mass customisation and one-to-one marketing

Figure 5.25 below shows the frequency and percentage distribution of responses to the statement 'ICTs provide SMEs with extraordinary capability to target specific groups of individuals precisely and enable them to practise mass customisation and one-to-one marketing strategies'.

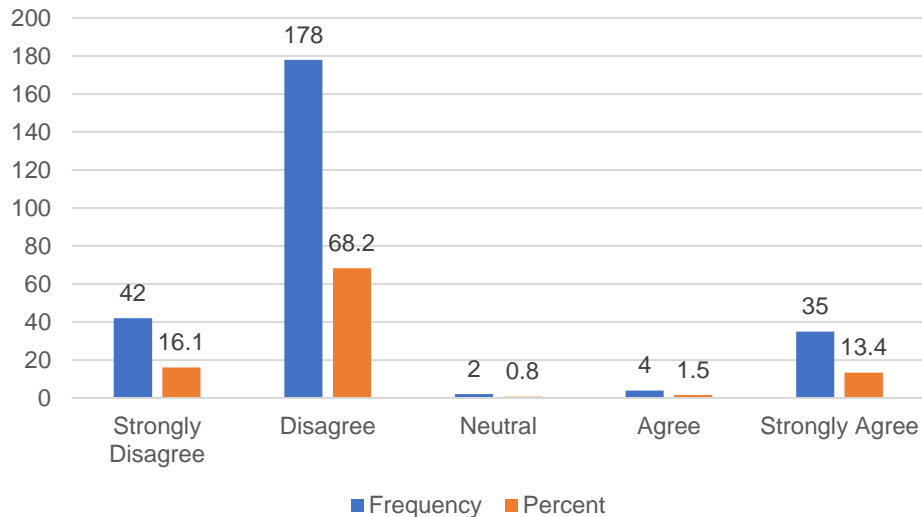


Figure 5.25: Mass customisation and one-to-one marketing

As shown in Figure 5.25 above, the majority of respondents (178 or 68.2%) disagreed and a further 42 (16.1%) strongly disagreed that ICTs had enabled their firms to target specific groups of individuals precisely and to practise mass customisation and one-to-one marketing strategies. On the other hand, 4 respondents (1.5%) agreed and 35 (13.4%) strongly agreed with this statement. Only 2 respondents (0.8%) expressed a neutral response.

A chi-square test was conducted to determine whether the ICTs adopted by manufacturing SMEs had enabled them to target specific groups of individuals precisely and to practise mass customisation and one-to-one marketing strategies. The results of this test ($X^2 = 403.617$; $df = 4$; $P = 0,001$) showed that these findings were insignificant, which suggests that there was no link between the technologies adopted by manufacturing SMEs and enhanced marketing strategies.

A study conducted by Pech and Vrchota (2022) asserts that despite changes in production techniques, mass production is not feasible for manufacturing SMEs due to a lack of compatible machinery.

5.7.9 Regional, national, and global coordination of activities

Figure 5.26 below shows the frequency and percentage distribution of responses to the statement ‘ICTs enhance the company’s ability to coordinate activities regionally, nationally, and globally, creating many new interrelationships’.

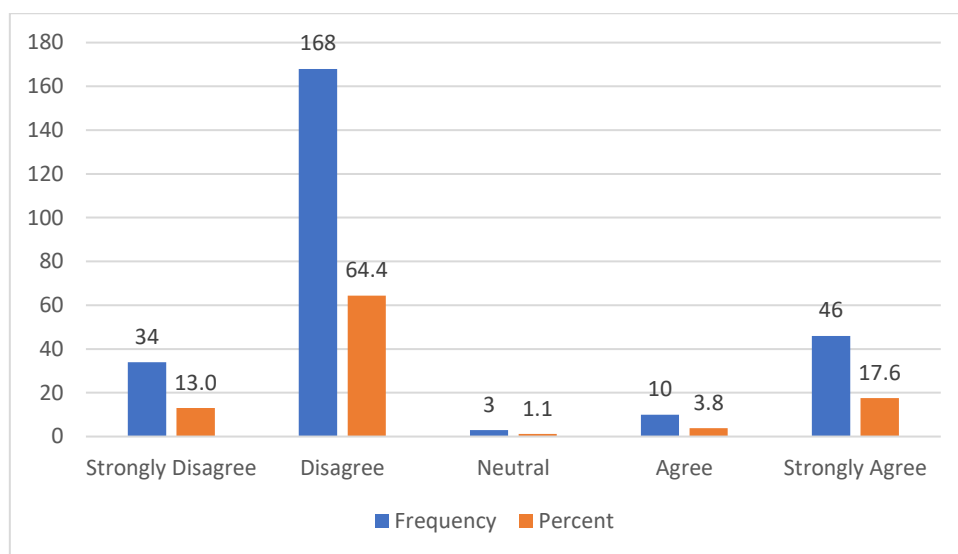


Figure 5.26: Regional, national, and global coordination of activities

As shown in Figure 5.26 above, the majority of manufacturing SMEs in KZN (77.4%) either disagreed (168 or 64.4%) or strongly disagreed (34 or 13%) with the above statement. On the other hand, 46 respondents (17.6%) strongly agreed and 10 (3.8%) agreed with this statement. Only 3 respondents (1.1%) expressed a neutral response.

The results of a chi-square test ($X^2 = 344.46$; $df = 4$; $P = 0,001$) showed that the ICTs adopted by these SMEs had not enhanced their ability to coordinate their activities on regional, national, and global levels.

A study conducted by Hånell *et al.* (2019: 517) asserts that technology can be utilised by manufacturing SMEs to overcome barriers of distance and time by allowing firms

to coordinate and monitor their production processes online. However, a firm’s inability to coordinate its manufacturing activities results in a lack of profitability and efficiency (Sifumba, Mothibi and Ezeonwuka 2017).

5.7.10 Cost reduction, improved productivity, and increased growth possibilities

Figure 5.27 below shows the frequency and percentage distribution of responses to the statement ‘Technology reduces business costs, improves productivity, and strengthens growth possibilities’.

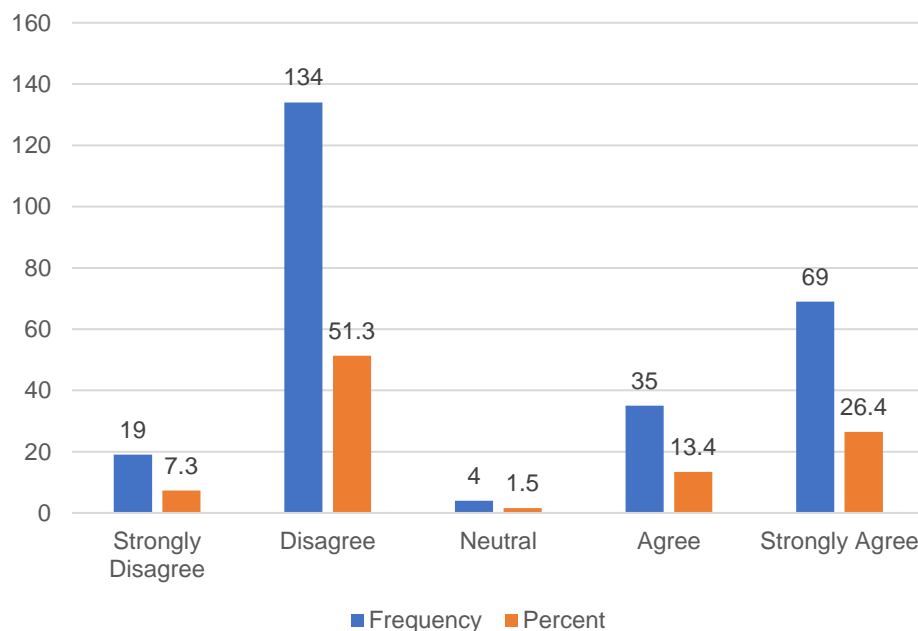


Figure 5.27: Cost reduction, improved productivity, and increased growth possibilities

As shown in Figure 5.27 above, 134 respondents (51.3% of the sample) disagreed and a further 19 (7.3%) strongly disagreed that the technologies adopted by their firms had enabled them to reduce business costs, improve productivity, and strengthen their growth possibilities. On the other hand, 69 respondents (26.4%) strongly agreed and 35 (13.4%) agreed with this statement. Only 4 respondents (1.5%) expressed a neutral response.

A study conducted by Chege and Wang (2020: 265) found that manufacturing SMEs had been able to reduce costs by automating their business operations as ICT enhanced their productivity and the effectiveness of their organisational activities. However, in this study, the results of a chi-square test ($X^2 = 244.881$; $df = 4$; $P = 0,001$) failed to corroborate the above assertion. On the other hand, the agreement of approximately 40% of respondents with the statement indicates that these SMEs have embraced innovation and departed from traditional ways of thinking. This signals a paradigm change that is positive for the development of these SMEs in the global economy. Studies conducted by Ndlela (2022) and Sharma and Singh (2023) found that manufacturing SMEs had not only adjusted to change, but had also pioneered it by adopting cutting-edge technical approaches.

5.7.11 Principal component analysis

The component matrix shown in Table 5.6 below further illuminates the perceptions of manufacturing SMEs in KZN regarding the benefits associated with technology adoption.

Table 5.6: Component matrix: Benefits of the adoption of technologies

Rotated Component Matrix^a

Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization. A. Rotation converged in 5 iterations

C	Component		
	1	2	3
4IR technologies enable manufacturing SMEs to respond to pressure to remain competitive and improve their economic potential	0,172	0,077	0,755
Technology provides greater efficiency and versatility for manufacturing SMEs	0,006	0,102	0,816
4IR technologies enable manufacturing SMEs to better streamline workflows by tracking time taken in the manufacturing process.	0,428	0,225	0,489
The adopted technologies allow manufacturing SMEs to increase collaboration across different marketing channels	0,777	-0,068	0,046
When appropriately integrated, technology can improve relationships by making it easier for employees and customers to communicate	0,816	-0,057	0,045
ICTs facilitate the selective automation of processes related to supporting the field sales force and integrating sales activity into the company's information structure	0,499	0,372	0,335
The adopted technologies enable SMEs to facilitate the gathering of valuable competitive knowledge and consumer-related information that simplifies marketing decision processes	0,607	0,185	0,179
ICTs provide SMEs with extraordinary capability to target specific groups of individuals precisely and enable them to practise mass customisation and one-to-one marketing strategies	0,363	0,599	0,290
ICTs enhance the company's ability to coordinate activities regionally, nationally, and globally, creating many new interrelationships	0,101	0,837	-0,053
Technology reduces business costs, improves productivity, and strengthens growth possibilities	-0,201	0,736	0,224

A component test was conducted on the variables that measured the benefits of the adoption of 4IR technologies by manufacturing SMEs in KZN. The component matrix shows a statistical analysis of the data presented in Figures 5.18 to 5.27 above. Three components were identified, and significant correlations were found in all three components.

The results obtained from the component matrix appear to contradict the findings of previous studies that have shown that technology can be utilised by SMEs to reduce business costs and improve productivity. A significant correlation of the variable 'Technology reduces business costs, improves productivity, and strengthens growth possibilities' was found with component 2 (0.736). This calls into question the claims made in previous studies that technology can reduce costs and improve the productivity of SMEs. The discrepancy observed could potentially stem from the challenges faced when using technology.

A significant correlation of the variable 'The adopted technology allows manufacturing SMEs to increase collaboration across different marketing channels' was found with component 1 (0.777), which suggests that technology adoption does not always lead to enhanced collaboration between SMEs and diverse marketing channels. These findings clearly demonstrate that there is insufficient statistical data to support the conclusions drawn in previous studies.

A significant correlation of the variable 'Technology provides greater efficiency and versatility for manufacturing SMEs' was found with component 3 (0.816). Less significant correlations were found for the variables 'ICTs facilitate the selective automation of processes related to supporting the field sales force and integrating sales activity into the company's information structure' (0.499) and '4IR technology enables manufacturing SMEs to better streamline workflows through tracking time taken in the manufacturing process' (0.489).

5.8 Section D: Barriers to the adoption of technologies

For SMEs in the manufacturing sector, the path towards adopting and utilising 4IR technologies is often fraught with challenges and barriers. In order to fully understand the complexities of technology adoption in the context of SMEs, it is important to highlight the barriers standing in the way of a smooth transition to the digital age.

5.8.1 Cost of technology adoption

Figure 5.28 below shows the frequency and percentage distribution of responses to the statement 'High costs associated with the adoption of technology negatively impact the success of manufacturing SMEs'.

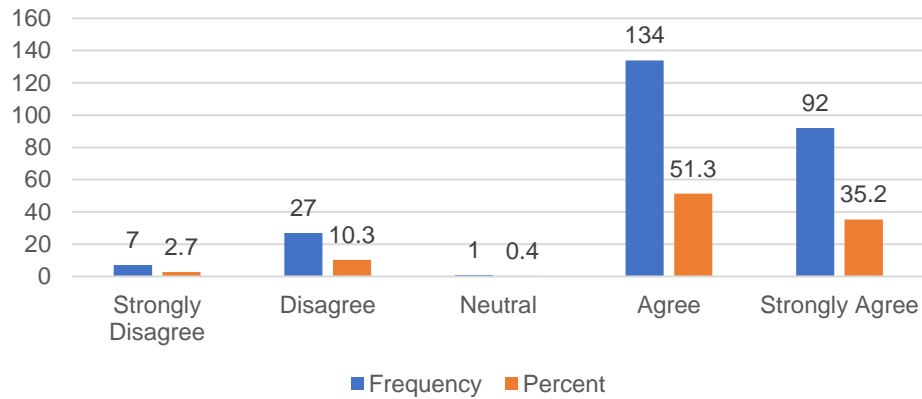


Figure 5.28: Cost of technology adoption

As shown in Figure 5.28, the majority of respondents (134 or 51.3%) agreed and a further 92 (35.2%) strongly agreed that high costs associated with the adoption of technology had negatively impacted the success of their firms. These findings indicate that the majority of manufacturing SMEs (86.5%) believed that the costs of technology adoption had influenced their decisions with regard to implementing 4IR technologies for manufacturing purposes. On the other hand, 13% of respondents either disagreed (27 or 10.3%) or strongly disagreed (7 or 2.7%) with this statement, which indicates that the success of their businesses had not been affected or influenced by ICT financing. Only 1 respondent (0.4%) expressed a neutral response.

The results of a chi-square test ($X^2 = 260.054$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that adopting and implementing new technologies often requires an extensive financial commitment. It also suggests that manufacturing SMEs have difficulty affording technical developments. Due to the necessity of prioritising financial resources for essential endeavours such as staffing and daily operational costs, technology investments present an obstacle for SMEs, particularly in their early stages of development (Rabonda 2023; Mathenjwa 2023).

Studies conducted by Widyastuti and Irwansyah (2018), Ntuli (2022), and Mhlongo *et al.* (2023) assert that a firm's decision to implement a technology is strongly influenced by the affordability of the technology, and that the use of technologies such as CC has been shown to reduce expenses.

5.8.2 Maintenance requirements

Figure 5.29 below shows the frequency and percentage distribution of responses to the statement ‘Maintenance of 4IR technology hinders the successful implementation of technology by manufacturing SMEs’.

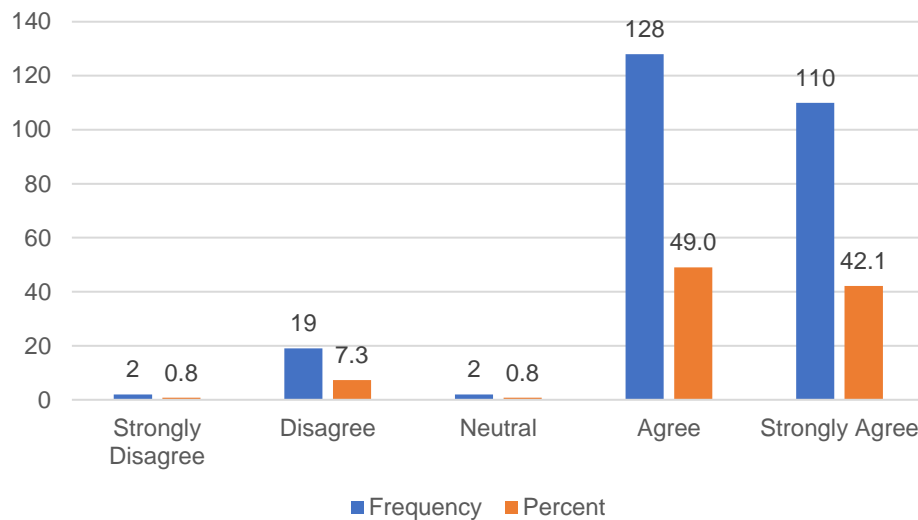


Figure 5.29: Maintenance requirements

As shown in Figure 5.29 above, slightly less than half of the respondents (128 or 49%) agreed and a further 110 (42.1%) strongly agreed that burdens associated with the maintenance of 4IR technologies had hindered the successful implementation of such technologies in their firms. These findings indicate that the majority of manufacturing SMEs find it challenging to implement technologies successfully due to requirements to continuously upgrade the technologies, including software. On the other hand, 8.1% of respondents either disagreed (19 or 7.3%) or strongly disagreed (2 or 0.8%) with this statement, which indicates that the successful implementation of technologies in their firms had not been hindered by maintenance requirements. Only 2 respondents (0.8%) expressed a neutral response.

The results of a chi-square test ($X^2 = 291.739$; $df = 4$; $P = 0,001$) indicated that the maintenance costs associated with 4IR technologies hinder the successful implementation of such technologies by manufacturing SMEs.

Because software degrades and hardware components gradually lose their functionality over time, SMEs need to set aside finances for recurring maintenance of hardware and software (Darko *et al.* 2017: 324). Failure to set aside financing for technology upgrades leads to decreased system efficiency, potential incompatibility issues, and increased security risks (Bvuma and Marnewick 2020: Ndlela 2022). The alignment of technology with current practices has been identified as an issue that hinders SMEs' sustainability (Bakri *et al.* 2021).

5.8.3 Security vulnerabilities

Figure 5.30 below shows the frequency and percentage distribution of responses to the statement 'Security vulnerabilities associated with 4IR technologies influence resistance to technology adoption'.

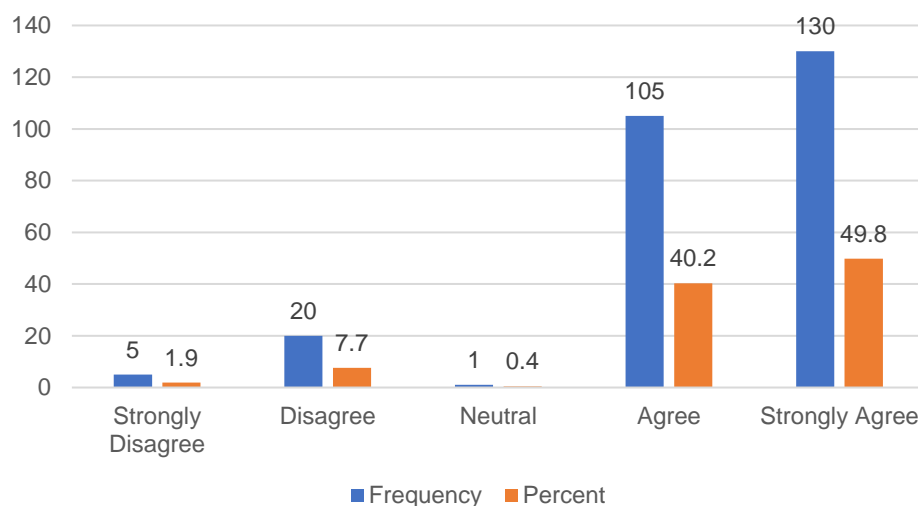


Figure 5.30: Security vulnerabilities

As shown in Figure 5.30 above, 130 respondents (49.8% of the sample) strongly agreed and a further 105 (40.2%) agreed that security vulnerabilities associated with 4IR technologies had influenced resistance to the adoption of such technologies by their firms. On the other hand, 20 respondents (7.7%) disagreed and 5 (1.9%) strongly disagreed with this statement. Only 1 respondent (0.4%) expressed a neutral response.

The results of a chi-square test ($X^2 = 282.123$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that security concerns are a significant factor contributing to the failure of manufacturing SMEs to adopt 4IR technologies.

Failure to thoroughly assess risks and put in place the required security measures to safeguard their operations and data puts manufacturing SMEs at risk of losing confidential business information, which can be detrimental to their existence. These findings highlight the urgency for manufacturing SMEs to prioritise training and skills development in order to implement new technologies effectively and securely. SMEs in the manufacturing industry have been found to be reluctant to use technologies due to the risk of potential system disruptions that can adversely affect their business operations (Asgary, Ozdemir and Özyürek 2020). Many manufacturing SMEs prefer to use traditional business methods because the use of technologies poses security challenges for them (Fahlevi *et al.* 2019).

5.8.4 Lack of infrastructure to support technology adoption

Figure 5.31 below shows the frequency and percentage distribution of responses to the statement ‘Lack of infrastructure to support technology adoption limits the successful implementation of technology’.

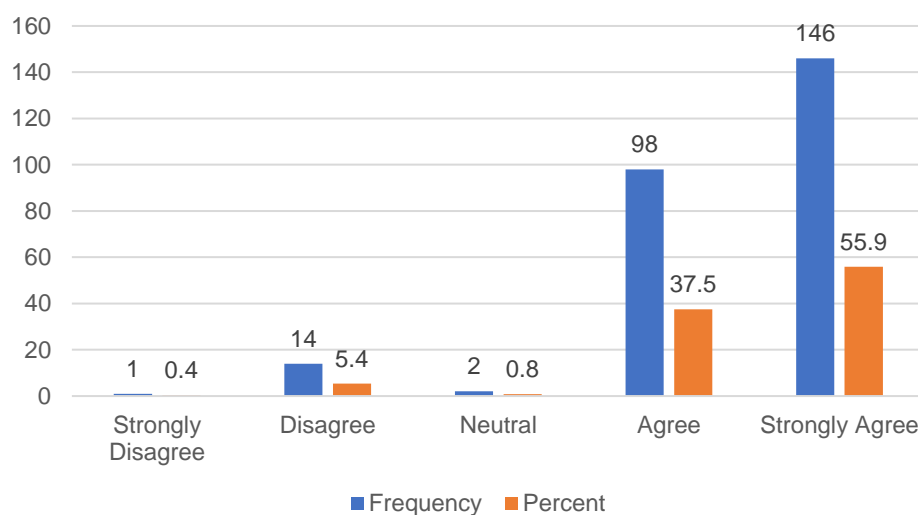


Figure 5.31: Lack of infrastructure to support technology adoption

As shown in Figure 5.31 above, the majority of respondents (146 or 55.9%) strongly agreed and a further 98 (37.5%) agreed that a lack of infrastructure to support technology adoption had hindered their implementation of technology. Only 5.8% of respondents either disagreed (14 or 5.4%) or strongly disagreed (1 or 0.4%) with this statement, and 2 respondents (0.8%) expressed a neutral response. These findings indicate that the majority of manufacturing SMEs find it challenging to implement technologies successfully without the necessary technological infrastructure.

The results of a chi-square test ($X^2 = 335.188$; $df = 4$; $P = 0,001$) indicated that a lack of infrastructure significantly contributes to the inability of manufacturing SMEs to adopt ICTs.

While a study conducted by Maisiri and van Dyk (2021: 11) found that infrastructural challenges restrict manufacturing SMEs from implementing new technologies, including servers, hardware, software, and systems, the ability to secure infrastructure that enables the adoption of technology encourages manufacturers to adopt technology (Sharma, Govindan *et al.* 2021). The findings of this study clearly indicate that the cost of purchasing and maintaining IT infrastructure can heavily burden manufacturing SMEs in South Africa, especially those with limited resources (Kativhu, Iwara and Mwale 2021).

5.8.5 Incompatibility and complexity

Figure 5.32 below shows the frequency and percentage distribution of responses to the statement 'Incompatibility and complexity of 4IR technologies hinder their successful adoption'.

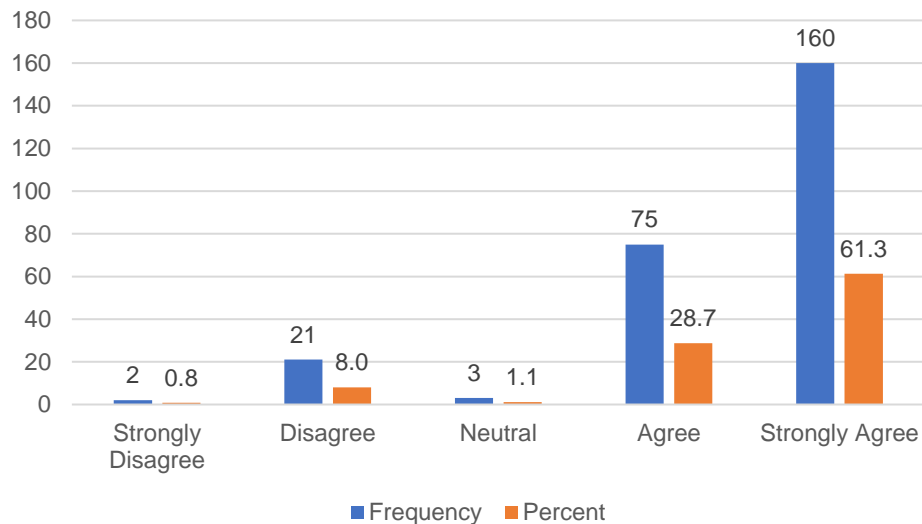


Figure 5.32: Incompatibility and complexity

As shown in Figure 5.32 above, the majority of respondents (160 or 61.3%) strongly agreed and a further 75 (28.7%) agreed that the incompatibility and complexity of 4IR technologies had hindered the successful adoption of such technologies by their firms. On the other hand, 21 respondents (8%) disagreed and 2 (0.8%) strongly disagreed with this statement. Only 3 respondents (1.1%) expressed a neutral response.

The results of a chi-square test ($\chi^2 = 345.877$; $df = 4$; $P = 0,001$) showed a strong relationship between the technology adoption and the compatibility of technology. These findings indicate that there is a link between perceived ease-of-use and technology adoption by manufacturing SMEs. The findings of this study clearly indicate that manufacturing SMEs in KZN use outdated technologies that are not compatible with 4IR technologies.

A study conducted by Matsepe and van der Lingen (2022: 4) found that the adoption of new technologies by SMEs was critically dependent on the usability of the technologies and that the complexity of advanced information systems inhibited their adoption. Attributes of technology users, such as a lack of education and a fear of change, may result in their reluctance to utilise technologies (Yoon, Lim and Park 2020). Without appropriate technical support, manufacturing SMEs may struggle to maintain compatibility between different systems, which may lead to inefficiencies or even a complete failure to integrate (Ogwu and Naicker 2023).

5.8.6 Lack of strategies for technology adoption

Figure 5.33 below shows the frequency and percentage distribution of responses to the statement 'Lack of understanding of the strategic importance of 4IR technologies limits SME success'.

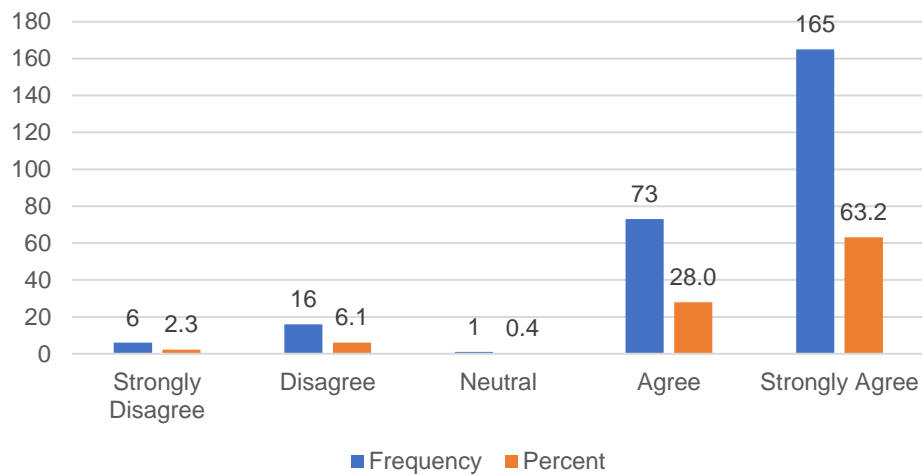


Figure 5.33: Lack of strategies for technology adoption

As shown in Figure 5.33 above, the majority of respondents (165 or 63.2%) strongly agreed and a further 73 (28%) agreed that a lack of understanding of the strategic importance of 4IR technologies had limited the success of their firms. On the other hand, 16 respondents (6.1%) disagreed and 6 (2.3%) strongly disagreed with this statement. Only 1 respondent (0.4%) expressed a neutral response.

The results of a chi-square test ($X^2 = 268.253$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that there is a link between 4IR technology strategies and SME success. These findings suggest that the absence of strategy development has a detrimental impact on SMEs.

As a result of the 4IR's significant technological developments, the growth of manufacturing SMEs will be drastically restricted if they fail to innovate due to a lack of understanding of the strategic significance of 4IR technologies (Han and Trimi 2022). Formal procedures for information processing and strategic management are

necessary to aid managers in developing strategies, structures, and procedures to improve the performance of SMEs (Kitsios and Kamariotou 2019: 2).

5.8.7 Lack of access to government assistance programmes

Figure 5.34 below shows the frequency and percentage distribution of responses to the statement ‘Lack of awareness of government assistance programmes and limited access to such programmes hinder the success of manufacturing SMEs’.

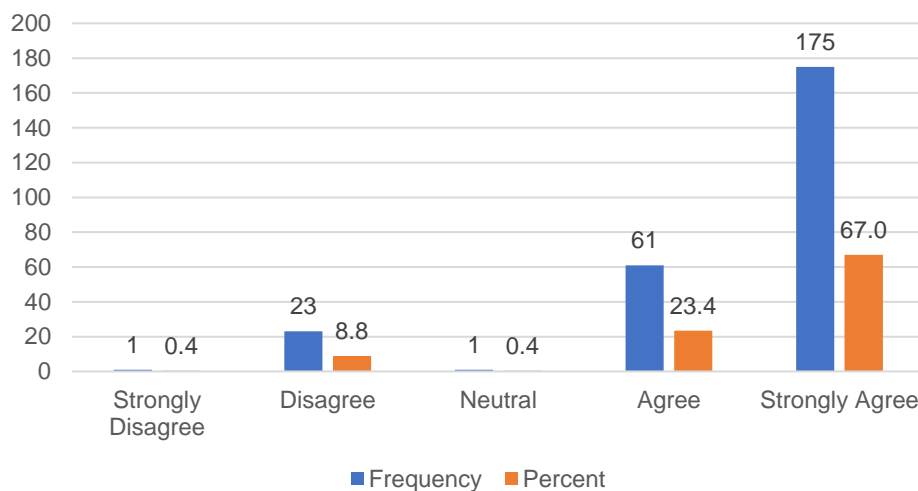


Figure 5.34: Lack of access to government assistance programmes

As shown in Figure 5.34 above, a total of 90.4% of respondents either strongly agreed (175 or 67%) or agreed (61 or 23.4%) that a lack of awareness of government assistance programmes and limited access to such programmes had hindered the success of their firms. On the other hand, 23 respondents (8.8%) disagreed and 1 respondent (0.4%) strongly disagreed with this statement. Only 1 respondent (0.4%) expressed a neutral response. These findings highlight the significance of government assistance with the training and financing needs of SMEs.

The results of a chi-square test ($X^2 = 407.142$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that there is a link between awareness of government assistance programmes and ICT adoption.

A study conducted by Moos and Sambo (2018) found that a lack of awareness of government assistance programmes is one of the major challenges faced by manufacturing SMEs. SMEs have been unable to innovate using emerging technologies due to a lack of government funding to support the adoption of new technologies (Ombongi and Long 2018: 43).

5.8.8 Lack of education

Figure 5.35 below shows the frequency and percentage distribution of responses to the statement ‘Lack of education results in manufacturing SMEs’ unpreparedness for 4IR technology adoption’.

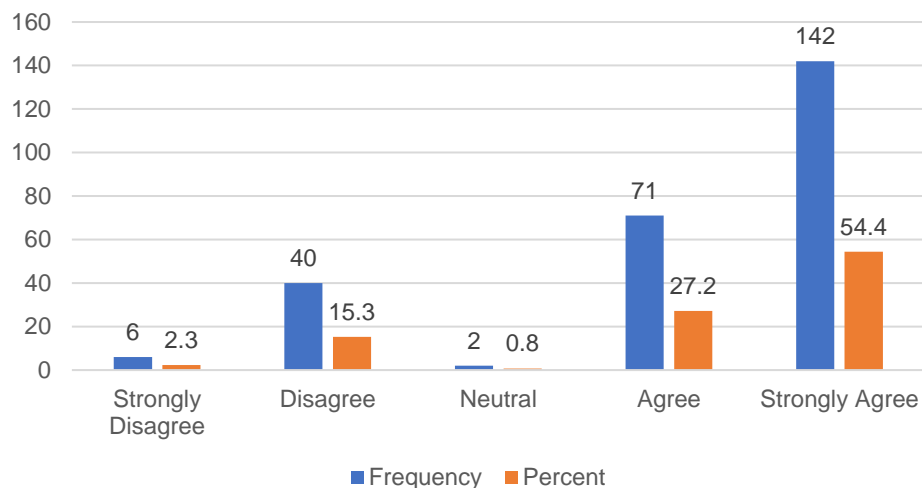


Figure 5.35: Lack of education

As shown in Figure 5.35 above, the majority of respondents (142 or 54.4%) strongly agreed and a further 71 (27.2%) agreed that a lack of education had resulted in the unpreparedness of their firms for 4IR technology adoption. These findings indicate that the majority of managers of manufacturing SMEs believe that there is a link between lack of education and 4IR unpreparedness. On the other hand, 17.6% of respondents either disagreed (40 or 15.3%) or strongly disagreed (6 or 2.3%) with this statement. Only 2 respondents (0.8%) expressed a neutral response.

The results of a chi-square test ($\chi^2 = 253.272$; $df = 4$; $P = 0,001$) indicated a strongly significant relationship between education levels and ICT adoption readiness in manufacturing SMEs.

Despite the impact of technological developments on their operations, South African manufacturing SMEs are characterised by their use of unskilled and semi-skilled labour (Ntuli 2022). As the successful implementation of technology by manufacturers is dependent on the skills they possess, this has negatively impacted the preparedness of SMEs for the 4IR (Serumaga-Zake and van der Poll 2021). However, the results of this study suggest that education is not the only prerequisite for the adoption of ICT. This is evident from the empirical findings presented in Section 5.5.5 with regard to the educational qualifications of SME managers. While most of the respondents in this study possessed formal educational qualifications, the level of ICT adoption in their firms was not necessarily high.

5.8.9 Lack of awareness of government policies and regulations

Figure 5.36 below shows the frequency and percentage distribution of responses to the statement ‘Lack of awareness of government policies and regulations negatively impacts manufacturing SMEs’.

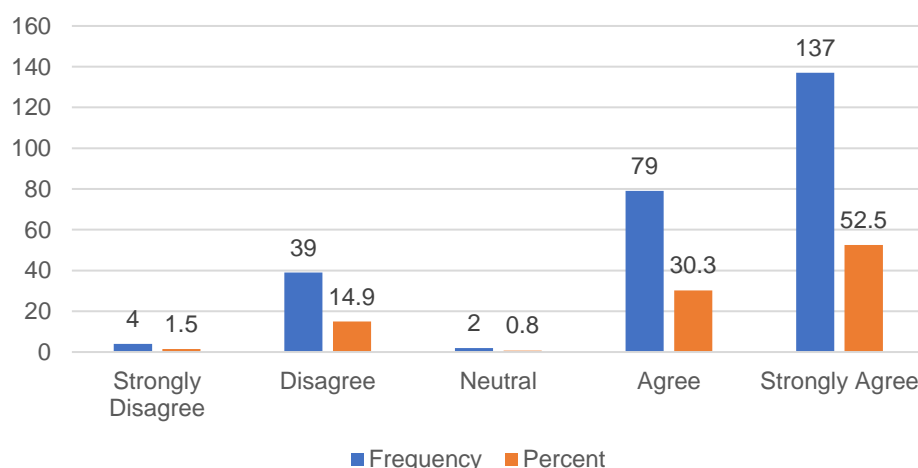


Figure 5.36: Lack of awareness of government policies and regulations

As shown in Figure 5.36 above, the majority of respondents (82.8%) either strongly agreed (137 or 52.5%) or agreed (79 or 30.3%) that a lack of awareness of government policies and regulations had negatively impacted their firms. On the other hand, 39 respondents (14.9%) disagreed and 4 (1.5%) strongly disagreed with this statement. Only 2 respondents (0.8%) expressed a neutral response.

A chi-square test was conducted to establish whether a lack of awareness of government policies and regulations had negatively impacted manufacturing SMEs. The results of this test ($X^2 = 247.64$; $df = 4$; $P = 0,001$) indicated that these findings were significant.

Studies conducted by Mukherjee (2018: 6), Muriithi (2017: 40) and Nkwabi and Mboya (2019: 2) have found that manufacturing SMEs face significant challenges with adverse policies, the regulatory environment, weak linkages with support services, and insufficient access to market knowledge, innovation, and financing. Muafi *et al.* (2021: 28) and Ahmed, A.A (2022: 3) suggest that the the government should be aware of the IT environment, security, the legitimacy of IT systems, and legal issues in order to encourage IT and e-commerce usage.

5.8.10 Lack of managerial knowledge and skills

Figure 5.37 below shows the frequency and percentage distribution of responses to the statement 'Lack of managerial knowledge and skills in 4IR technologies is a significant impediment to the success of manufacturing SMEs'.

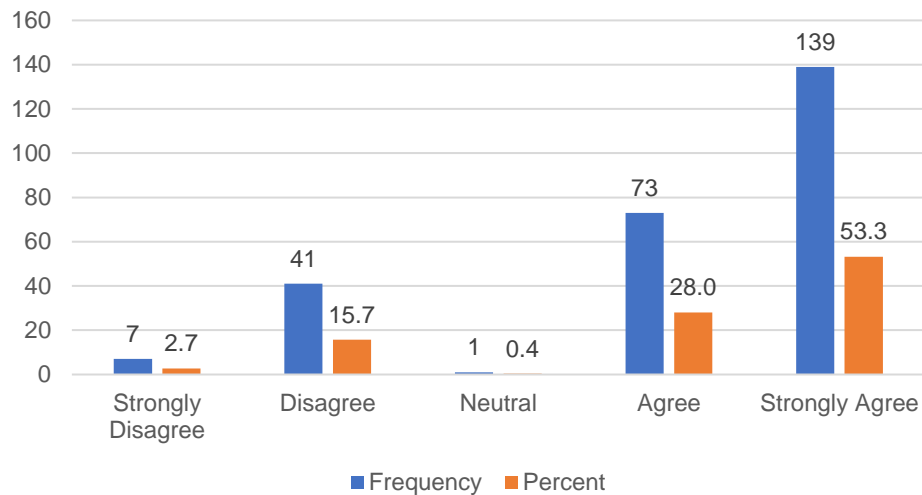


Figure 5.37: Lack of managerial knowledge and skills

Figure 5.37 above shows that the majority of respondents (81.3%) either strongly agreed (139 or 53%) or agreed (73 or 28%) that a lack of managerial knowledge and skills in 4IR technologies had significantly impeded the success of their firms. On the other hand, 41 respondents (15.7%) disagreed and 7 (2.7%) strongly disagreed with this statement. Only 1 respondent (0.4%) expressed a neutral response.

The results of a chi-square test ($X^2 = 244.383$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that a deficiency in management skills, and especially technical skills, hinders ICT adoption. Thus, manufacturing SMEs continue to experience challenges in the adoption and implementation of 4IR technologies due to inadequate knowledge, which could result in manufacturing SMEs losing interest in the benefits of ICT.

These findings resonate with those of Nunden *et al.* (2022: 4), who found that the majority of SME owners in the eThekweni district in KZN were unskilled and undereducated to carry out business operations, which had negatively impacted the success of these SMEs. As the innovation process requires knowledge of the concepts and procedures involved, manufacturing SMEs are less able to coordinate the application of emerging technologies than larger enterprises due to a lack of such knowledge (Haj Osman and Singh 2022).

5.8.11 Cost of technological expertise

Figure 5.38 below shows the frequency and percentage distribution of responses to the statement ‘The cost of keeping up with the latest technologies limits technology adoption’.

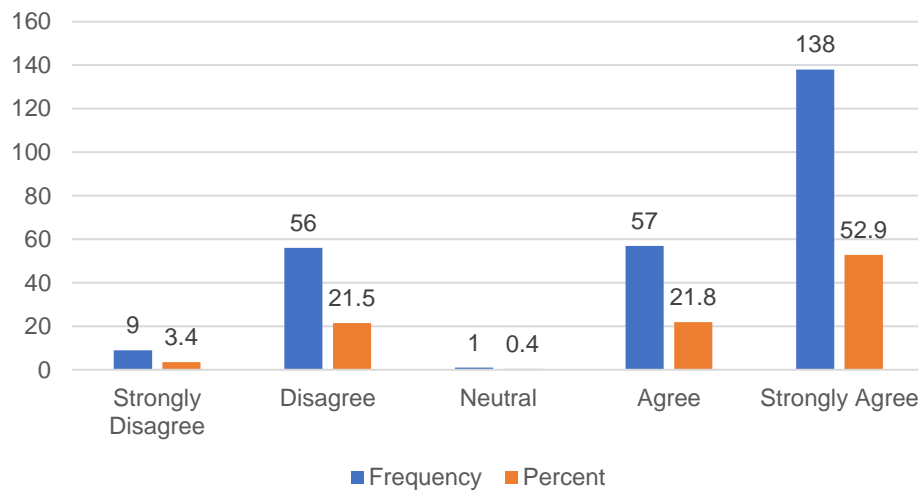


Figure 5.38: Cost of technological expertise

As shown in Figure 5.38 above, the majority of respondents (74.7%) either strongly agreed (138 or 52.9%) or agreed (57 or 21.8%) that the cost of keeping up with the latest technologies had limited technology adoption in their firms. On the other hand, 56 respondents (21.5%) disagreed and 9 (3.4%) strongly disagreed with this statement. Only 1 respondent (0.4%) expressed a neutral response.

The results of a chi-square test ($X^2 = 227.716$; $df = 4$; $P = 0,001$) showed a strong relationship between costs and ICT adoption. These findings supplement those presented in Sections 5.8.8 and 5.8.10, which indicate that a lack of education and a lack of managerial knowledge and skills both influence ICT adoption. It is therefore evident that the cost of keeping up to date with the latest technologies is a concern for manufacturing SMEs in KZN, as they are compelled to acquire the services of experts to help them integrate technologies that will enable them to continue operating in a highly dynamic and competitive environment.

Manufacturing SMEs face challenges in implementing emerging technologies such as smart manufacturing due to the costs of such technologies, operational constraints, and insufficient skills and experience among their employees (Ghobakhloo and Ching 2019). In addition, it is difficult for manufacturing SMEs to obtain financing for the adoption of emerging technologies (Gumbi and Twinomurinzi 2020: 41).

5.8.12 Principal component analysis

The component matrix shown in Table 5.7 below shows an analysis of the variables pertaining to the challenges associated with technology adoption by manufacturing SMEs in KZN.

Table 5.7: Component matrix: Barriers to the adoption of technologies

Rotated Component Matrix^a

Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization. A. Rotation converged in 3 iterations

D	Component	
	1	2
High costs associated with the adoption of technology negatively impact the success of manufacturing SMEs	0,637	-0,070
Maintenance of 4IR technology hinders the successful implementation of technology by manufacturing SMEs.	0,741	-0,109
Security vulnerabilities of 4IR technologies influence resistance to technology adoption	0,781	0,102
Lack of infrastructure to support technology adoption limits the successful implementation of technology	0,791	0,028
Incompatibility and complexity of 4IR technologies hinders their successful adoption	0,709	0,186
Lack of understanding of the strategic importance of 4IR technologies limits SME success	0,719	0,241
Lack of awareness of government assistance programmes and limited access to such programmes hinder the success of manufacturing SMEs	0,518	0,377
Lack of education results in manufacturing SMEs' unpreparedness for 4IR technology adoption	0,234	0,653
Lack of awareness of government policies and regulations negatively impacts manufacturing SMEs	0,136	0,698
Lack of managerial knowledge and skills in 4IR technologies is a significant impediment to the success of manufacturing SMEs	0,008	0,748
Lack of training results in manufacturing SMEs' unpreparedness for 4IR technology adoption	0,018	0,704
The cost of keeping up with the latest technologies limits technology adoption	-0,044	0,552

A component test was conducted on the variables that measured hindrances to technology adoption by manufacturing SMEs. The component matrix shows a statistical analysis of the data presented in Figures 5.28 to 5.38 above. Two components were identified.

The results of this study provide robust evidence that supports the findings of previous studies regarding the financial aspects of technology adoption and maintenance in various contexts, particularly within business organisations. A significant correlation of the variable 'High costs associated with the adoption of technology negatively impact the success of manufacturing SMEs' was found with component 1 (0.637). This implies that the initial capital of SMEs has a substantial influence on their technology adoption. Previous studies have emphasised that SMEs should prioritise investing in technology essentials, such as tools, computers, software, and training programmes, at the start. The findings of this study confirm those of previous studies and highlight the significance of the financial consequences associated with the utilisation of technology.

A significant correlation of the variable 'Maintenance of 4IR technology hinders the successful implementation of technology by manufacturing SMEs' was found with component 1 (0.741). This highlights the recurring financial obligations that accompany technology adoption, which include updating software, repairing hardware, safeguarding against cyber threats, obtaining technical assistance, and providing regular technological training for staff.

Significant correlations of the variables 'Security vulnerabilities associated with 4IR technologies influence resistance to technology adoption' and 'Lack of infrastructure to support technology adoption limits the successful implementation of technology' were found with component 1 (0.781 and 0.791 respectively). These findings confirm, in line with the literature reviewed in Chapter 2 of this study, that security vulnerabilities and infrastructure constraints are both strongly correlated with technology adoption. The findings further highlight the critical role that infrastructure plays in improving the security and resilience of technological systems. Such consistency not only demonstrates the validity of this study but also contributes to the body of knowledge on the intricate relationships between technological advancements, vulnerabilities, and the supporting technical infrastructure.

A significant correlation of the variable 'Incompatibility and complexity of 4IR technologies hinder their successful adoption' was found with component 1 (0.709).

This highlights the challenges that SMEs encounter when incorporating 4IR technologies into their current manufacturing procedures and is in line with an extensive body of well-reviewed research.

A significant correlation of the variable 'Lack of awareness of government assistance programmes and limited access to such programmes hinder the success of manufacturing SMEs' was found with component 1 (0.518). This is consistent with an array of literature that thoroughly details comparable issues experienced by SMEs in many industries and regions. Such studies have often emphasised the essential role that government assistance plays in boosting the SME sector. This result highlights the gravity of the problem and shows that the success of manufacturing SMEs is severely hampered by a lack of knowledge combined with limited access to government support initiatives.

A significant correlation of the variable 'Lack of education results in manufacturing SMEs' unpreparedness for 4IR technology adoption' was found with component 2 (0.653). This clearly highlights a problem in the current manufacturing landscape and indicates that a lack of education and training prevents SMEs from incorporating innovative technologies into their operations, which renders them less capable to compete globally with companies that have embraced the 4IR.

Similarly, a significant correlation of the variable 'Lack of awareness of government policies and regulations negatively impacts manufacturing SMEs' was found with component 2 (0.698). This indicates an additional layer of complexity in the difficulties faced by manufacturing SMEs. Government policies and regulations, while essential for maintaining ethical business practices and consumer protection, can be complex and difficult to understand. SMEs often find it challenging to manage this complicated regulatory landscape as they lack the resources of larger enterprises. The sustainability and expansion prospects of SMEs can be seriously harmed by unintentional breaches, legal problems, and financial penalties that result from a lack of regulatory knowledge.

5.9 Section E: Strategies for technology adoption

5.9.1 Hiring technologically knowledgeable employees

Figure 5.39 below shows the frequency and percentage distribution of responses to the statement 'Part of my strategy to successfully leverage ICT is to employ technologically knowledgeable employees'.

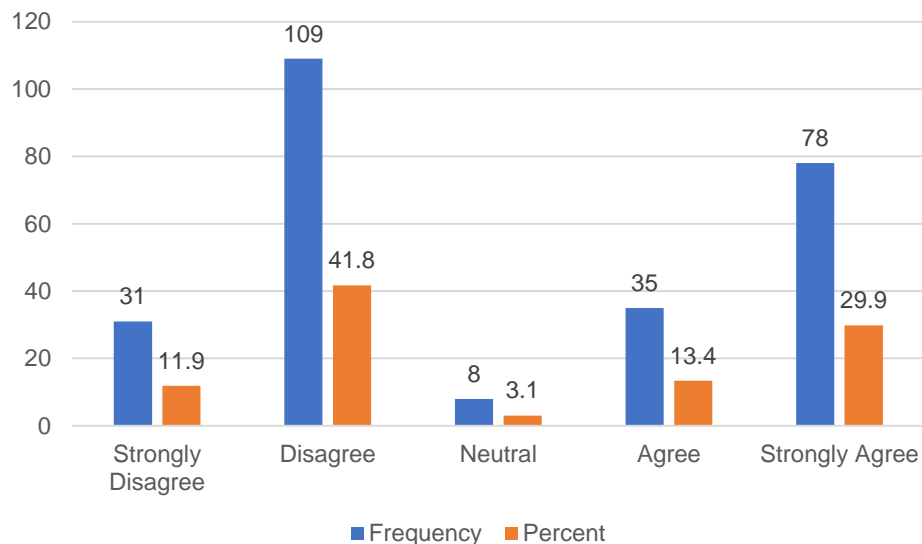


Figure 5.39: Hiring technologically knowledgeable employees

As shown in Figure 5.39 above, the majority of respondents (109 or 41.8%) disagreed and a further 31 (11.9%) strongly disagreed that employing technologically knowledgeable employees was part of their firm's strategy to successfully leverage ICT. On the other hand, 78 respondents (29.9%) strongly agreed and 25 (13.4%) agreed with this statement. Only 8 respondents (3.1%) expressed a neutral response.

The results of a chi-square test ($X^2 = 126.621$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that there is no correlation between SMEs' ability to employ a technologically knowledgeable workforce and their sustainability.

Thomas (2020: 168) highlights that the successful adoption of innovations by an organisation is dependent on the organisation's ability to utilise them to keep pace with consumers' constantly changing demands and expectations. Therefore, a technology adoption strategy that addresses the need to employ technologically knowledgeable

staff is crucial for SMEs to remain relevant and competitive in an environment of vast and rapid technological development (Saarikko, Westergren and Blomquist 2020: 2).

5.9.2 Designing internal policies to promote technology adoption

Figure 5.40 below shows the frequency and percentage distribution of responses to the statement ‘My organisation has designed internal policies to promote ICT adoption’.

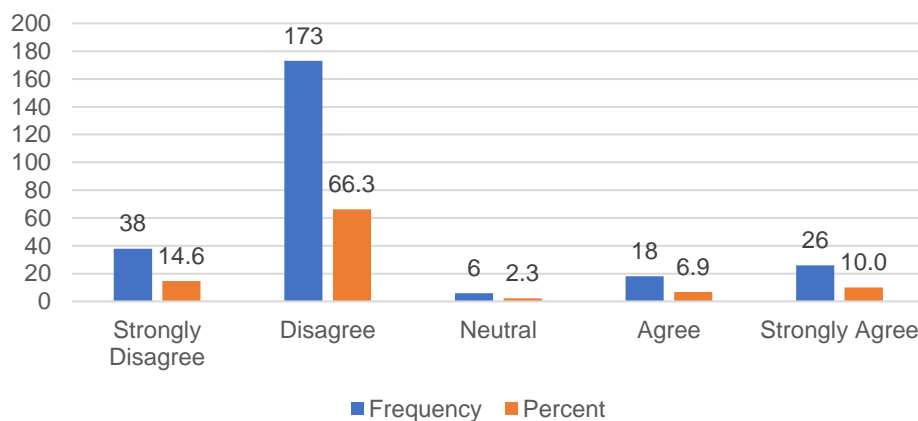


Figure 5.40: Designing internal policies to promote technology adoption

As shown in Figure 5.40 above, the majority of respondents (173 or 66.3%) disagreed and a further 38 (14.6%) strongly disagreed with this statement. On the other hand, 18 respondents (6.9%) agreed and a further 26 (10%) strongly agreed with the statement. Only 6 respondents (6.9%) expressed a neutral response.

The results of a chi-square test ($X^2 = 359.862$; $df = 4$; $P = 0,001$) showed that these findings were significant, which suggests that a lack of organisational policies to promote ICT adoption hinders the adoption of ICT.

A study conducted by Ntuli (2022) asserts that the inability to develop internal policies that promote technology adoption hampers the sustainability of manufacturing SMEs in the competitive environment in which they find themselves. In addition to developing internal policies for promoting innovation, it is crucial that manufacturers understand the importance of utilising technology (Anshari and Almunawar 2021).

5.9.3 Collaboration with larger firms

Figure 5.41 below shows the frequency and percentage distribution of responses to the statement 'My organisation has strategies in place to improve collaboration with larger firms'.

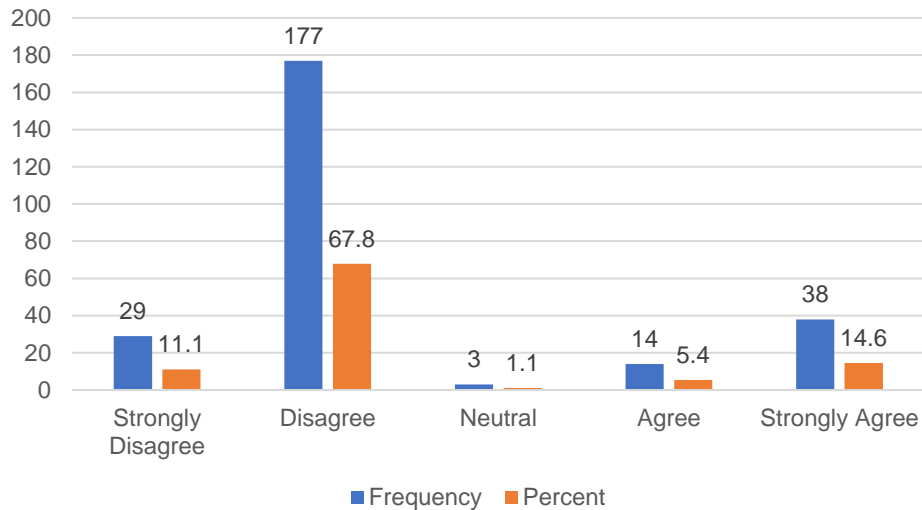


Figure 5.41: Collaboration with larger firms

As shown in Figure 5.41 above, a total of 78.9% respondents either disagreed (177 or 67.8%) or strongly disagreed (29 or 11.1%) that their firms had strategies in place to improve collaboration with larger firms. On the other hand, 38 respondents (14.6%) strongly agreed and 14 (5.4%) agreed with the statement. Only 3 respondents (1.1%) expressed a neutral response.

The results of a chi-square test ($X^2 = 386.874$; $df = 4$; $P = 0,001$) showed that these findings were significant, which suggests that a lack of organisational strategies to improve collaboration with larger firms impedes technology adoption.

Davis (2015: 8) states that larger organisations have networks, expertise, and financial resources that nearly all start-up enterprises lack, which gives them advantages in areas in which knowledge accumulates with experience. This is because large firms

have been found to have the regulatory experience and expertise necessary to successfully market new products (Roth *et al.* 2018).

5.9.4 Skills development

Figure 5.42 below shows the frequency and percentage distribution of responses to the statement ‘I have a skills development strategy in place to ensure successful implementation of technology’.

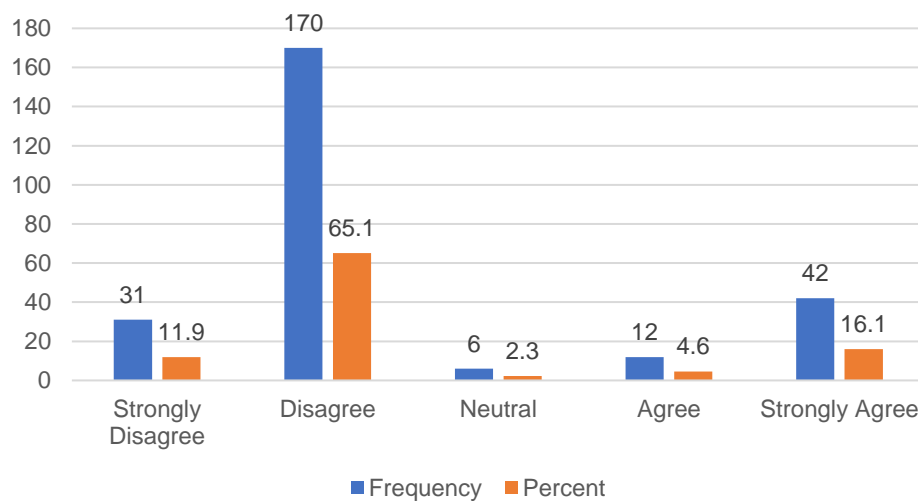


Figure 5.42: Skills development

As shown in Figure 5.42 above, a total of 77% of respondents either disagreed (170 or 65.1%) or strongly disagreed (31 or 11.9%) that their firms had a skills development plan to ensure successful implementation of technology. On the other hand, 42 respondents (16.1%) strongly agreed and a further (12 or 4.6%) agreed with this statement. Only 6 respondents (2.3%) expressed a neutral response.

The results of a chi-square test ($X^2 = 348.291$; $df = 4$; $P = 0,001$) showed a significant link between inability to sustain a firm and the absence of a skills development strategy for 4IR technology adoption.

While Ntuli (2022) emphasises the necessity of having a strategy that seeks to promote successful adoption and implementation of technology, a study conducted by Ngibe and Lekhanye (2020) found that manufacturing SMEs in KZN were not skilled

enough to develop and implement such a strategy. Implementation of innovative solutions and strategies can be further impeded by a lack of managerial and leadership skills (Furawo and Scheepers 2018: 8).

5.9.5 Infrastructural planning

Figure 5.43 below shows the frequency and percentage distribution of responses to the statement ‘My organisation has an integrated infrastructure plan to prepare itself for the digital economy’.

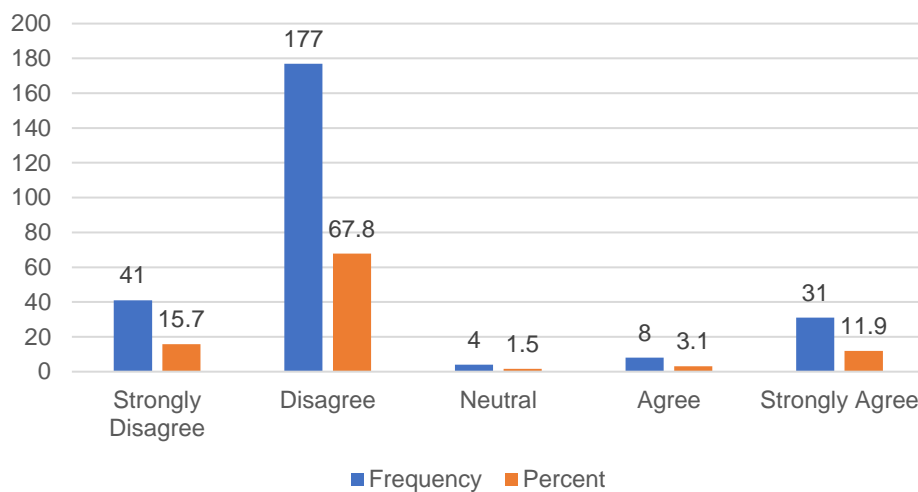


Figure 5.43: Infrastructural planning

As shown in Figure 5.43 above, the majority of respondents (177 or 67.8%) disagreed and a further 41 (15.7%) strongly disagreed with this statement. On the other hand, 31 respondents (11.9%) strongly agreed and 8 (1.5%) agreed that their organisations had integrated infrastructure plans to prepare for the digital economy. Only 4 respondents (1.5%) expressed a neutral response.

The results of a chi-square test ($X^2 = 391.318$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that the majority of manufacturing SMEs do not have an integrated infrastructure strategy in place to enable them to prepare for the digital economy. These findings suggest that a lack of infrastructure prevents manufacturing SMEs in KZN from participating in the digital economy.

Insufficient access to public infrastructure services is a significant barrier to the survival and expansion of SMEs as it limits their operations and restricts their access to raw materials and customers (Leboea 2017: 78). A study conducted by Nkwabi and Mboya (2019: 2) asserts that insufficient access to technological infrastructure and poor network coverage hinders the adoption of technology.

5.9.6 Evaluating benefits and risks of technology adoption

Figure 5.44 below shows the frequency and percentage distribution of responses to the statement ‘There is a strategy in place to actively evaluate the benefits and risks of IT adoption in order to assess whether its benefits outweigh its risks’.

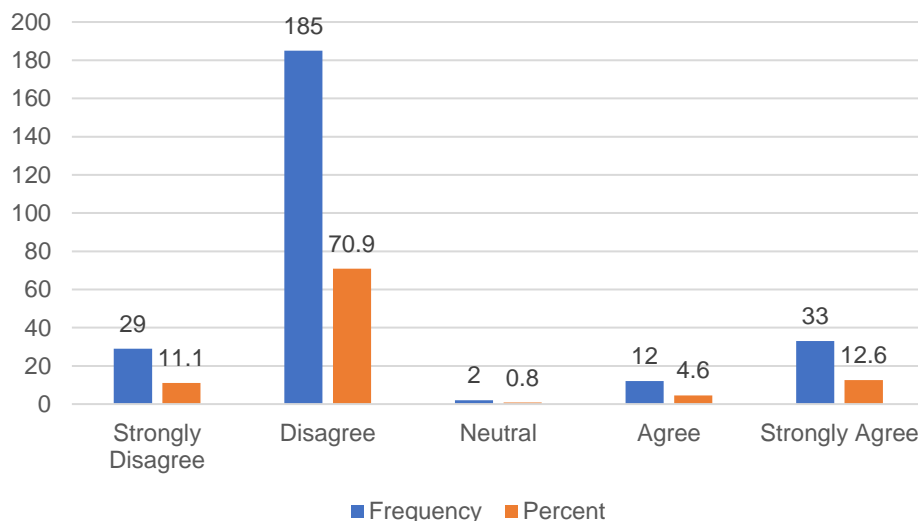


Figure 5.44: Evaluating benefits and risks of technology adoption

As shown in Figure 5.44 above, the majority of respondents (185 or 70.9%) disagreed and a further 29 (11.1%) strongly disagreed with this statement. On the other hand, 33 respondents (12.6%) strongly agreed and 12 or (4.6%) agreed that their firm had an IT risk/benefit assessment strategy in place. Only 2 respondents (0.8%) expressed a neutral response.

The results of a chi-square test ($X^2 = 434.46$; $df = 4$; $P = 0,001$) supported the assertion that manufacturing SMEs in KZN lack strategies to evaluate whether the benefits of IT outweigh its risks.

A study conducted by Da Roit and Iannuzzi (2022: 4) highlights that operating without a policy in place to monitor both the implementation of technology and the evaluation of the risks associated with its adoption is futile for SMEs. Inadequate planning, a lack of formal processes, and a lack of understanding of the relationship between digital technology, company performance, and outsourced IT expertise have all been found to impede technology adoption (Canhoto *et al.* 2021: 1682). Rana *et al.* (2019: 141) found that manufacturing SMEs have failed to thoroughly assess alternatives for each requirement when selecting technologies.

5.9.7 Evaluating organisational readiness for technology adoption

Figure 5.45 below shows the frequency and percentage distribution of responses to the statement 'I have a strategy to evaluate my organisation's capability to reap benefits from IT adoption'.

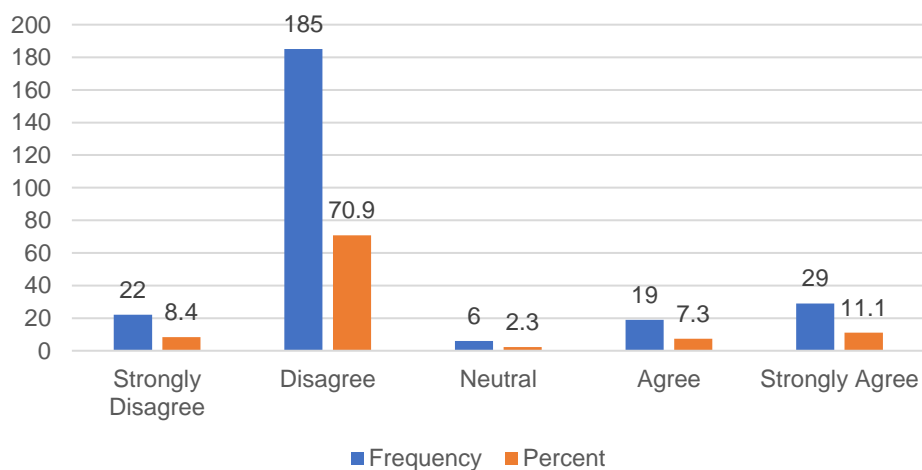


Figure 5.45: Evaluating organisational readiness for technology adoption

As shown in Figure 5.45 above, the majority of respondents (185 or 70.9%) disagreed and a further 22 (8.4%) strongly disagreed that their firms had strategies in place to evaluate their capability to reap the benefits of IT adoption. On the other hand, 29 respondents (11.1%) strongly agreed and 19 (7.3%) agreed with this statement.

The results of a chi-square test ($X^2 = 427.64$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that a lack of strategic evaluation of the benefits of technology adoption hinders technology adoption.

A study conducted by Rana *et al.* (2019: 141) found that manufacturing SMEs lack guidelines on how to utilise technology beneficially as well as information on how technology can address challenges related to manufacturing. In addition, Soni *et al.* (2022: 2) found that manufacturing SMEs lack the capacity to select the technologies that best fit their needs from a range of available options.

5.9.8 Improving compatibility of applications

Figure 5.46 below shows the frequency and percentage distribution of responses to the statement ‘My organisation has a strategy to encourage shareholder cooperation in improving the compatibility of IT applications with other SMEs that are active in different industries’.

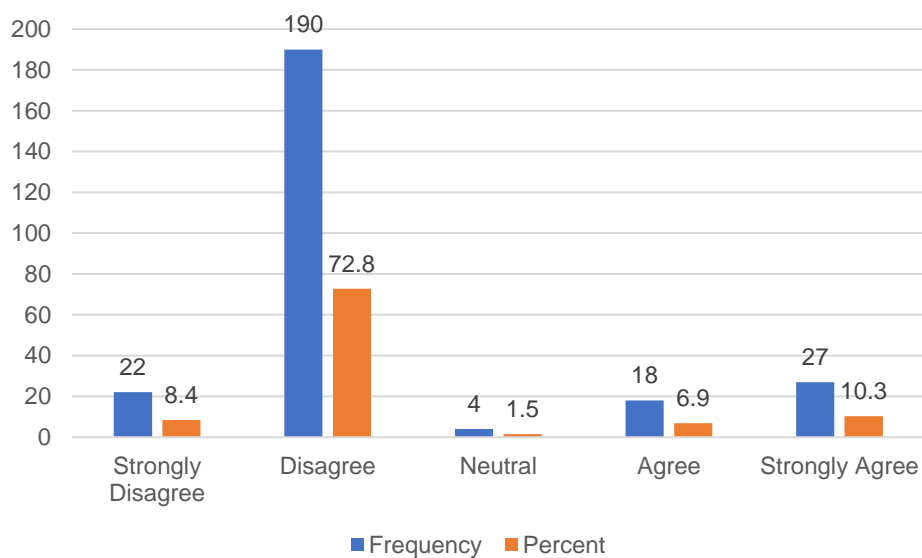


Figure 5.46: Improving compatibility of applications

As shown in Figure 5.46 above, the majority of respondents either disagreed (190 or 72.8%) or strongly disagreed (22 or 8.4%) that their firms had strategies to encourage shareholder cooperation in improving the compatibility of IT applications with other SMEs that were active in different industries. On the other hand, 27 respondents

(10.3%) strongly agreed and 18 (6.9%) agreed with the statement. Only 4 respondents (1.5%) expressed a neutral response.

The results of a chi-square test ($X^2 = 460.322$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that a lack of strategy to encourage shareholder cooperation in improving the compatibility of IT applications with other SMEs that are active in different industries impedes technology adoption.

A study conducted by Al-Maskari, Al Riyami and Ghnimi (2022) asserts that it is essential for SMEs to embrace changes that accompany the emergence of new technologies because this enables them to collaborate with other firms. Developing strategic technical partnerships across enterprises is vital for SMEs that lack resources, as this improves their performance (Ali Qalati *et al.* 2020: 2).

5.9.9 Ensuring security of online activities

Figure 5.47 below shows the frequency and percentage distribution of responses to the statement 'I have designed strategies to regulate secure online transaction activities to reduce or prevent the attacks of hackers, viruses, and spyware'.

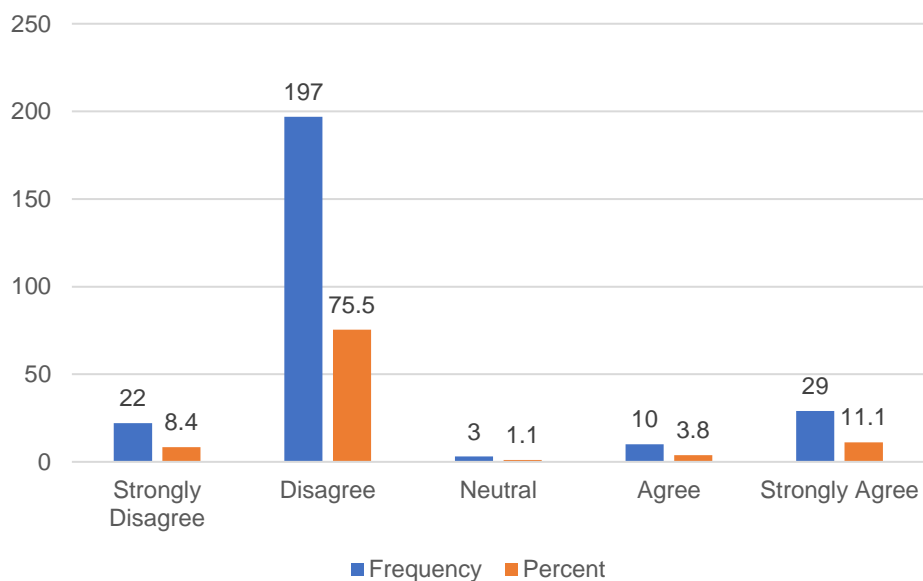


Figure 5.47: Ensuring security of online activities

As shown in Figure 5.47, the majority of respondents (197 or 75.5%) disagreed and a further 22 (8.4%) strongly disagreed with this statement. On the other hand, 29 respondents (11.1%) strongly agreed and a further 10 (3.8%) agreed that their firms had strategies to regulate secure online transactions. Only 3 respondents (1.1%) expressed a neutral response.

The results of a chi-square test ($X^2 = 509.939$; $df = 4$; $P = 0,001$) showed that these findings were significant, which suggests that the inability to develop a strategy to regulate secure online transaction activities hinders technology adoption by manufacturing SMEs.

According to Lazarova-Molnar, Mohamed and Al-Jaroodi (2019: 121); Zaeem and Barber (2020), all firms have the ability to create explicit security and privacy policies, as well as rules for enforcing and executing such policies. However, manufacturing SMEs have been found to lack IT security procedures, which can be attributed to a lack of the necessary expertise to manage IT security (Parkin, Fielder and Ashby 2016: 69; Siddiqi, Pak and Siddiqi 2022). This is exacerbated by the reluctance of owners of manufacturing SMEs to utilise advanced technologies.

5.9.10 Improving technological knowledge and skills

Figure 5.48 below shows the frequency and percentage distribution of responses to the statement 'My organisation has a strategy to ensure that the level of ICT knowledge and skills is improved'.

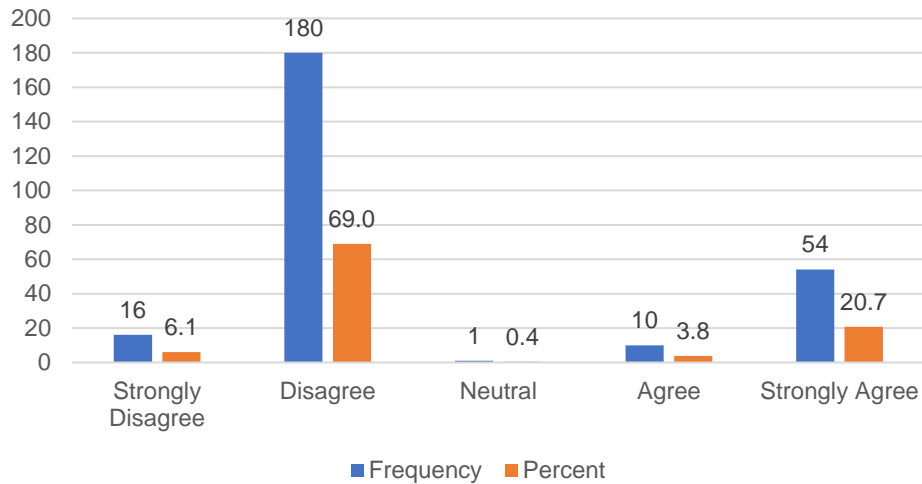


Figure 5.48: Improving technological knowledge and skills

As shown in Figure 5.49 above, a total of 75.1% of respondents either disagreed (180 or 69%) or strongly disagreed (16 or 6.1%) that their firms had strategies to improve their ICT knowledge and skills. On the other hand, 54 respondents (20.7%) strongly agreed and 10 (3.8%) agreed with this statement. Only one respondent (0.4%) expressed a neutral response.

The results of a chi-square test ($X^2 = 422.391$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that the lack of a strategy to improve ICT knowledge and skills is a contributing factor to non-adoption of technology.

ICT contributes significantly to the current knowledge economy (Dumsday and Yeoh 2023). However, there is a low level of innovation and competitiveness in the SME sector due to a lack of technical and managerial abilities among owners and managers of SMEs (Cele, Nyide and Stainbank 2022: 4). This skills deficiency has significant effects on SMEs, including limited access to markets, limited operational efficiency, ineffective communication and collaboration, and data management challenges (Enaifoghe and Ramsuraj 2023; Mhlongo *et al.* 2023). It is therefore crucially important for SMEs to address these impediments by investing in ICT infrastructure, skills, and knowledge.

5.9.11 Investment in technology adoption

Figure 5.49 below shows the frequency and percentage distribution of responses to the statement 'My organisation has an investment strategy in place for technology adoption'.

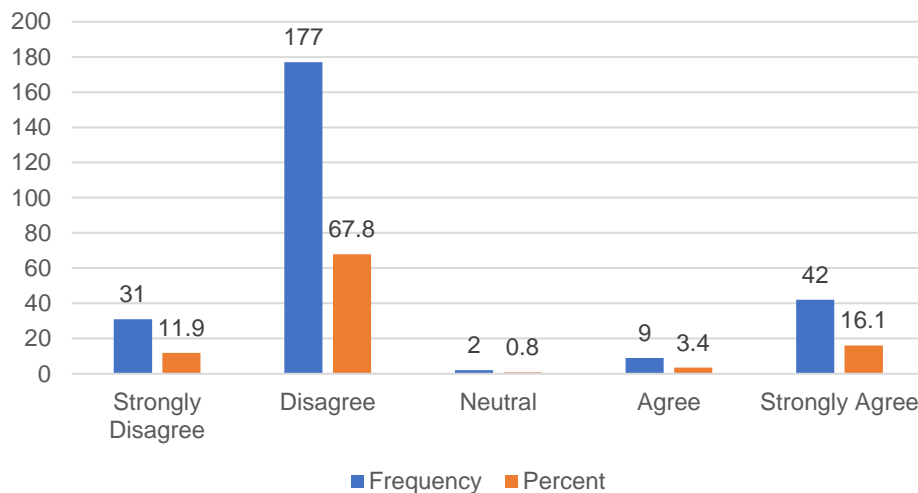


Figure 5.49: Investment in technology adoption

As shown in Figure 5.49 above, a total of 79.7% of respondents either disagreed (177 or 67.8%) or strongly disagreed (31 or 11.9%) that their firms had investment plans for future technology adoption. This could be due to a lack of sufficient funding for technology adoption. On the other hand, 42 respondents (16.1%) strongly agreed and a further 9 (3.4%) agreed that their firms had investment strategies for technology adoption. Only 2 respondents (0.8%) expressed a neutral response.

The results of a chi-square test ($X^2 = 393.004$; $df = 4$; $P = 0,001$) showed that these findings were significant, which indicates that not having an investment strategy in place for technology adoption hinders technology adoption.

Studies conducted by Ngibe, Lekhanya and Garbharran (2019: 1) and Kusuma *et al.* (2020) emphasise that SMEs in the manufacturing sector in South Africa face ongoing challenges and inequity as a result of their financial struggles. Lack of investment has been identified as an inhibiting factor to technology adoption (Nair, Chellasamy and Singh 2019: 696). This is of particular concern for SMEs, as a lack of investment

threatens their sustainability (Annosi *et al.* 2019). Studies conducted by Maisiri *et al.* (2021) and Soni *et al.* (2022: 2) highlight the significance of creating a framework to evaluate organisational readiness for ICT adoption in SMEs to address this concern. Investment in technology is vital as it affects both the performance and the profitability of an organisation and enables executives to align IT strategy with business strategy (Kitsios and Kamariotou 2019: 2).

5.9.12 Principal component analysis

The component matrix shown in Table 5.8 below further illuminates the effectiveness of strategies for technology adoption by manufacturing SMEs in KZN.

Table 5.8: Component matrix: Strategies for technology adoption

Rotated Component Matrix^a

Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization. A. Rotation converged in 6 iterations

E	Component		
	1	2	3
Part of my strategy to successfully leverage ICT is to employ technologically knowledgeable employees	-0,064	0,154	0,737
My organisation has designed internal policies to promote ICT adoption	0,555	0,113	0,424
My organisation has strategies in place to improve collaboration with larger firms	0,224	-0,072	0,782
I have a skills development strategy in place to ensure successful implementation of technology	0,259	0,282	0,670
My organisation has an integrated infrastructure plan to prepare itself for the digital economy	0,749	0,121	0,212
There is a strategy in place to actively evaluate the benefits and risks of IT adoption in order to assess whether its benefits outweigh its risks	0,784	0,235	0,040
I have a strategy to evaluate my organisation's capability to reap benefits from IT adoption	0,460	0,589	0,086
My organisation has a strategy to encourage shareholder cooperation in improving the compatibility of IT applications with other SMEs that are active in different industries	0,367	0,688	0,065
I have designed strategies to regulate secure online transaction activities to reduce or prevent the attacks of hackers, viruses, and spyware	0,650	0,400	0,053
My organisation has a strategy to ensure that the level of ICT knowledge and skills is improved	-0,053	0,826	0,250
My organisation has an investment strategy in place for technology adoption	0,320	0,621	0,036

A component test was conducted on the variables that measured the development of strategies to overcome technology adoption impediments. The component matrix shows a statistical analysis of the data presented in Figures 5.39 to 5.49 above. Three

components were identified, and significant correlations were found in all three components.

A significant correlation of the variable 'Part of my strategy to successfully leverage ICT is to employ technologically knowledgeable employees' was found with component 3 (0.737). This emphasises the value of a well-considered strategy for hiring technologically knowledgeable staff. While numerous previous studies assert that SMEs should prioritise attracting personnel with technological expertise, the results of this study indicate that manufacturing SMEs have failed to recognise the crucial role played by technologically adept staff members and to proactively incorporate them into their strategic frameworks.

A significant correlation of the variable 'I have designed strategies to regulate secure online transaction activities to reduce or prevent the attacks of hackers, viruses, and spyware' was found with component 1 (0.650). This study found a notable deficiency in the capacity of manufacturing SMEs to design and implement effective defences against these threats, which significantly hampers the adoption of ICT. In line with previous studies that have emphasised the need for cybersecurity precautions, these findings highlight a pressing need for SMEs to strengthen their cybersecurity measures. In addition, the empirical findings of this study highlight a lack of both ICT readiness and ICT implementation among manufacturing SMEs. This calls for a re-evaluation of techniques adopted in the past and offers essential insight into the gaps that still persist.

5.10 Qualitative analysis of data gathered from SMEs

This section examines a variety of perspectives obtained from the open-ended questions in Section F of the questionnaire directed towards manufacturing SMEs. The purpose of this section of the questionnaire was to obtain an understanding of the opinions of the managers of manufacturing SMEs regarding the adoption and integration of technology in the operations of their firms. The participants were provided with guidance to openly express their views on technology and its utilisation, collaboration with larger firms, strategies to overcome technological challenges, benefits of technology adoption, and diverse applications of technology.

Table 5.9: Themes and sub-themes emerging from interviews with industry experts

Theme	Subtheme
1. Utilisation of 4IR technologies	1. Data storage 2. Marketing 3. Collaboration with larger firms
2. Barriers to the adoption of 4IR technologies	1. Lack of funding 2. Technology integration 3. Lack of training

5.10.1 Theme 1: Utilisation of 4IR technologies

5.10.1.1 Subtheme 1: Data storage

When asked to describe the ways in which 4IR technologies were used in their firms, approximately a quarter of the respondents indicated that they used computers to store data. Some respondents indicated that cloud-based applications and services were utilised to store critical data. The following responses illustrate this finding:

Respondent 107: *“For my business, applications such as Microsoft OneDrive is used to store important data about finance of the business.”*

“We only use computer desktop to store data and records not for production.”

“In my firm computer is used to conduct sales online.”

“Computer is used to track business records.”

These findings are in line with those of a study conducted by Abner *et al.* (2020), who established that ICTs enable manufacturing SMEs to access data anywhere and at any time and thus aid in decision making. Elhusseiny and Crispim (2022: 1927) assert that the use of cloud technologies provides manufacturing SMEs with easy and affordable access to online data storage. In addition, collaborative teamwork can be enabled through applications such as Microsoft Teams (Rajagopaul *et al.* 2020: 8).

5.10.1.2 Subtheme 2: Marketing

When asked to describe the ways in which 4IR technologies are used in their firms, a sizeable majority of respondents indicated that their firms utilised technology for marketing purposes. The following responses illustrate this finding:

“The adopted innovation enables my firm to conduct research in order to keep up with the latest trends and monitor customer’s interest.”

“We use advertisements to market our product.”

“In our firm technology is used to marketing our brand.”

“The challenge is that we are growing company, so, for now the best strategy we use is digital marketing.”

It was also noted that the use of social media was gaining momentum within the small manufacturing sector. Almost half of the respondents indicated that they used social media for marketing purposes. The following responses illustrate this finding:

“Social media is the only way I use to promote my business.”

“The business uses online platforms for marketing.”

Jeza (2021: 62) asserts that due to the advancement of technology, every organisation needs a digital advertising strategy as an essential element in connecting with consumers and converting prospects into customers. Technology is a potent stimulant for brand marketing because it enables firms to engage with their audience in new and creative ways, track customer behaviour, and modify their plans in response to real-time data (Ayandibu *et al.* 2019: 1403).

5.10.1.3 Subtheme 3: Collaboration with larger firms

When asked whether their firms collaborated with larger firms, respondents expressed contrasting views about their firms' collaborative engagement. Only a few respondents indicated that their firms collaborate with larger firms. The following responses illustrate this finding:

Respondent 31: *“Yes as Nampak we have collaboration with larger firms like Coca-Cola, Clover, Valpre, and Woolworths.”*

Respondent 29: *“Yes, we collaborate with the large firms who have advanced software's that we cannot afford as a firm.”*

Respondent 19: *“Yes, we collaborate and most of the time on seasonal product.”*

More than half of the respondents indicated that their firms did not collaborate with larger firms. The following responses illustrate this finding:

“No, my firm does not collaborate with large firms.”

“We have no strategy in place to collaborate and overcome fourth industrial revolution challenges.”

Studies conducted by Akpan, Udoh and Adebisi (2022) and Odei and Hamplová (2022) found that manufacturing SMEs have reaped several benefits from collaborative work, including financial assistance and access to the latest technologies. Networking with other firms opens access to pertinent and beneficial information that can aid manufacturing SMEs in expanding and developing (Fubah and Moos 2022: 3). However, a study conducted by Zahoor *et al.* (2020) highlighted concerns regarding collaborative partnerships, particularly with regard to potential vulnerabilities to security breaches being created when sensitive information is acquired by collaborative partners.

5.10.2 Theme 2: Barriers to the adoption of 4IR technologies

The second theme that emerged from the qualitative data gathered from SMEs involved the challenges that impeded their effective adoption of ICTs, which included inadequate financial resources, challenges in harmonising diverse systems, and limited knowledge and skills.

5.10.2.1 Subtheme 1: Lack of funding

When asked to summarise their experiences of implementing ICT solutions, the majority of the respondents indicated that the inability to access financing had impeded them from adopting new technologies. The following responses illustrate this finding:

“Lack of finances is a problem since we depend on one machine to make our products.”

“The lack of finances does not allow our business to adopt new technology.”

“I tried to communicate with the service providers to subcontract with my business to service with technology finance is the problem.”

“Lack of funding is proving to be an inhibitor to my desire to adopt technology.”

A further barrier identified was the additional cost of hiring IT experts to maintain 4IR technologies.

“Maintaining the 4IR technology is costly and sometimes requires you to get experts in the field to come and do it”.

A study conducted by Adelowotan (2021: 40) asserts that a lack of convenient access to credit and financing options due to a lack of credit history and insufficient collateral security exacerbates the difficulty of accessing funding for technology adoption.

5.10.2.2 Subtheme 2: Integration of technology

When asked to summarise their experiences of implementing ICT solutions, some respondents indicated that they were apprehensive about problems that might arise from experimenting with new technologies or from integrating technology inappropriately. The following responses illustrate this finding:

“What I can say is challenges arise when the adopted technology does not align with your company’s needs.”

“It is complex to start using 4IR because it requires understanding to make it successful.”

In addition, respondents indicated that because manufacturing procedures are intricate and require precision, their firms frequently refrained from the complex challenge of implementing new technologies due to the risk of system breakdowns. The following responses illustrate this finding:

“The consequence of inappropriate integration of technology is that the system will be down.”

“Once the machine fails than operation it takes time to get it fixed because it is outsourced equipment.”

Studies conducted by Zamani (2022) and Dlamini (2022) found that manufacturing SMEs were apprehensive about the potential repercussions of ineffective technology deployment as this could intensify the burden on their limited resources, such as finances and personnel.

5.10.2.3 Subtheme 3: Lack of training

When asked to summarise their experiences of implementing ICT solutions, some respondents indicated that the inability to identify and provide appropriate

technological training that caters for their firms' specific needs was a challenge. The following responses illustrate this finding:

"We tried to implement digital operations we failed due to improper training; these technological equipment's need a person with sufficient information to operate the machine."

"We adopted a machine that makes production to be quick, but the problem is we found our self in high cost of training employees."

"The problem is not having the required IT capabilities, resources, or the support necessary to successfully implement these new technologies is an inhibiting factor to technology adoption."

It can therefore be concluded that it is essential to tailor training programmes to the specific needs of the enterprise in order to ensure that employees receive relevant and focused training. A study conducted by Hegab *et al.* (2023) emphasises that training programmes should focus on the vital technical skills that will ensure that firms achieve their business goals.

5.11 Conclusion

This chapter presented a thorough analysis of the quantitative data obtained from the manufacturing SME manager in KZN and further discussed aspects such as manufacturing SMEs demography, the use of 4IR technologies, benefits and barriers that influence the decision-making process for technology adaption, and the effectiveness of strategies utilised for technology adoption. In addition, two themes were developed from the qualitative questions that were on the questionnaire. The findings of this chapter revealed the challenges that manufacturing SMEs in KZN encounter with 4IR technology adoption. Which included amongst others, the lack of managerial digital skills needed to facilitate the adoption, lack of financial assistance from the government and lack of the competencies needed to device strategies for enhancing technology adoption. On the other hand, there manufacturing SMEs that should be commended that effectively adopted various technologies and were able to

reap the benefits of technology. The next chapter will discuss how the qualitative data was analysed.

CHAPTER SIX

QUALITATIVE ANALYSIS OF DATA GATHERED FROM INFORMATION TECHNOLOGY SPECIALISTS

6.1 Introduction

The previous chapter focused on analysing the quantitative data that portrayed the perceptions of owners and managers of manufacturing SMEs regarding the adoption of technology. Numerous trends and patterns were identified with regard to the adoption of technology in the manufacturing sector. The statistical analysis of the data provided insights into the utilisation and acceptance of technologies by manufacturing SMEs, including the rate at which these technologies were adopted and the perceived benefits and obstacles they presented.

This chapter presents the outcomes of discussions that were held with IT professionals in order to gain a comprehensive understanding of technologies that can be utilised by SMEs. In addition to bridging the gap between theory and practice, the experiences and expertise of these professionals provide valuable insights for SMEs seeking to adopt technology and assist in the development of a framework to guide technology adoption in SMEs.

6.2 Categorisation of industry experts

To illustrate the depth of expertise possessed by the IT experts who were interviewed, Table 6.1 below furnishes essential information concerning their specific areas of proficiency within the IT industry, the number of respondents within each specialisation, the number of years for which they have worked in the IT field, and their entrepreneurial ventures.

Table 6.1: Categorisation of industry experts

IT specialisation	Number of respondents	Number of years in the field	Entrepreneurial ventures
Software developer	3	5-7	Public and private sectors
Systems analyst	2	3-6	Owner of a company. Public sector
Information systems manager	1	10	IT company owner
Web designer	2	4-7	IT company owner. Private company
Telecommunication/ communication networks	2	5-8	Public company

This information assists in comprehending the diverse range of respondents interviewed and their levels of IT knowledge.

6.3 Themes and subthemes

Table 6.2 below shows the themes and subthemes that emerged from the interviews that were held with the IT experts.

Table 6.2: Themes emanating from interviews with industry experts

Theme	Subtheme
1. Utilisation of 4IR solutions	1. 3D printing 2. Manufacturing accounting software 3. Cloud-based software 4. SAP S/4HANA
2. Benefits of ICT adoption	1. Task simplification and enhancement 2. Improved competitiveness
3. Factors influencing ICT adoption	1. Preparedness for ICT adoption 2. Security issues 3. Financial background 4. Education 5. Attitude towards ICT 6. Availability of resources
4. Potential complications of ICT adoption	1. Integration issues 2. Impact of power outages and loadshedding 3. COVID-19

6.3.1 Theme 1: Utilisation of 4IR solutions

There is growing interest in technology adoption among manufacturing SMEs that previously relied on traditional methods for their operations. However, a lack of awareness of the broad spectrum of advanced technologies available and how they can be utilised continues to be a challenge. The 4IR solutions that emerged from the

interviews with the IT experts are categorised into four subthemes: 3D printing, manufacturing accounting software, cloud-based software, and SAP S/4HANA.

6.3.1.1 Subtheme 1: 3D printing

When asked to share their opinions on suitable technologies for manufacturing SMEs, respondents indicated that the emergence of 3D printing technology had provided small manufacturers with fresh prospects and avenues to explore. In line with previous studies, it was noted that 3D printing provides manufacturing SMEs with a more accurate and effective production strategy that reduces material waste and results in cost savings when compared to conventional techniques (Onu and Mbohwa 2021; Dhir *et al.* 2023). The following responses illustrate this finding:

Respondent 5: *“Like you would obviously know that for manufacturing sector there is a lot of advancement with the introduction of 3D and robotics. For example, before the technological advancement, techniques such as make-line were employed during which employees from various departments would be involved in making a shoe, you would have department or employees who were responsible for cutting the shoe material, then other departments would be responsible for stitching the shoe material and others lacing the shoe up until the shoe is complete, now we have machinery that does that in bulks.”*

Respondent 6: *“When it comes to your printing needs, 3D printing offers numerous choices in terms of materials like plastic or any other material”.*

It was also noted that 3D printing enables manufacturing SMEs to develop prototypes quickly, test innovative designs, and manufacture personalised products in batches, thereby ensuring fast and precise outcomes. The following responses illustrate this finding:

Respondent 1: *“There are several technologies or should say machinery that can be used by manufacturing SME like the engraving laser machine*

that enables SMEs to engrave the products according to customers specifications.”

Respondent 4: *“Previously, it seemed unimaginable to have such a high level of flexibility and customisation.”*

Studies conducted by Nazir and Khan (2022) and Alshahrani (2023) assert that larger corporations find it more convenient to adopt 3D printing technology than small businesses, which encounter significant challenges in doing so due to a lack of resources and access to the necessary equipment. However, studies conducted by Imad *et al.* (2022) and Kaba *et al.* (2023) found that computer numerical control machining has proved to be a cost-effective solution, particularly in scenarios that require efficient manufacturing of large quantities of products within a short time frame, as it is fast and requires minimal human labour.

6.3.1.2 Subtheme 2: Manufacturing accounting software

When asked to share their opinions on suitable technologies for manufacturing SMEs, respondents identified manufacturing accounting software as a key tool to assist manufacturers to manage their daily business operations and financial transactions. It was noted that manufacturing accounting software enables enterprises to streamline administrative procedures, cut operating expenses, and concentrate on strategic efforts that improve business sustainability. The following responses illustrate this finding:

Respondent 3: *“Generally, when you start a small business human capital is your first challenge, so you become the bookkeeper, project manager basically you play different roles. So, using the invoicing system is beneficial as it helps you to create a quote for invoices on the phone, you don’t necessarily need to be at the office or on your laptop. Also, because it is an accounting software it does the calculations for you.”*

Respondent 4: *“What comes to mind for right now is the pro-invoicing software that allows you using different invoice templates to create an*

invoice saving you time...there is what we call the Sage 50 as a cloud-based accounting and inventory solution that manufacturing SMEs can utilise because it provides features such as order management, inventory optimisation, and financial reporting.”

Manufacturing accounting software aims to efficiently coordinate and manage financial operations within the firm and thereby to facilitate seamless financial reporting. Studies conducted by Msomi *et al.* (2019), Bella, Apriyanti and Sriwijayanti (2023), and Thakker and Japee (2023) assert that manufacturing accounting software simplifies the routines involved in financial reporting and ensures accuracy and adherence to financial accounting regulations. This is beneficial to manufacturing SMEs because it aids them in making decisions, attracting investors, and complying with tax regulations (Imene and Imhanzenobe 2020).

6.3.1.3 Subtheme 3: Cloud-based software

When asked to share their opinions on suitable technologies for manufacturing SMEs, respondents indicated that cloud-based services offer manufacturing SMEs a variety of benefits, such as reduced expenses, adaptability, enhanced collaboration, and increased potential for growth. Cloud services were identified as particularly beneficial for manufacturing SMEs with substantial amounts of data or operational information. The following responses illustrate this finding:

Respondent 2: “Depending on the size of the company, for example if you are a startup, I would recommend using cloud services because it offers different packages, where you are charged based on the number of user and the services you require.”

Respondent 9: “It depends on the type of manufacturing needs, for some manufacturing SMEs cloud computing is used for storage.”

It was noted that service providers offer tailor-made packages for small businesses to provide them with affordable access to essential services. However, Respondents 2 and 8 stated that even though they considered the adoption of cloud-based services

to be essential, not all small businesses could afford to adopt them due to financial constraints, which were particularly a concern for newly-established SMEs.

As manufacturing procedures generate various forms of data, including product blueprints, manufacturing logs, stock information, and customer data, the expansion of data storage capacity is crucial for manufacturing organisations (Fisher *et al.* 2018; Mudzamba 2019). By incorporating cloud-based technologies, small manufacturing businesses can transform themselves into flexible, innovative, and customer-focused organisations that are able to navigate the dynamic business environment successfully (Jones-Esan, Nadda and Albright 2022; Waema 2022).

6.3.1.4 Subtheme 4: SAP S/4HANA

When asked to share their opinions on suitable technologies for manufacturing SMEs, respondents identified the enterprise resource planning software suite SAP S/4HANA as a useful tool to integrate various aspects of manufacturing SMEs' operations, such as finances, staff management, purchasing, and customer service. The following response illustrates this finding:

Respondent 10: "Manufacturing SMEs can consider using the SAP S/4HANA software, which is mostly used for electronic filling, human resource functions, such as payroll...SMEs can also utilise Microsoft Power BI for supply chain reporting, stock count, and inventory management."

It was also noted that using SAP S/4HANA can improve employee management and streamline activities such as recruitment, performance evaluation, and training. According to a study conducted by Tossavainen (2022), SAP S/4HANA automates and streamlines operational procurement processes by enabling employees to originate, manage, and track their own orders while automating their approval.

6.3.2 Theme 2: Benefits of ICT adoption

For manufacturing SMEs, incorporating technology is not a once-off decision but a significant strategy that enables them to make noticeable advancements and influences their success and sustainability. The benefits of ICT adoption that emerged from the interviews with IT experts are categorised into two subthemes: task simplification and enhancement, and improved competitiveness.

6.3.2.1 Subtheme 1: Task simplification and enhancement

When asked to share their experiences regarding the benefits of ICT adoption, respondents indicated that the incorporation of ICT in manufacturing has the potential to enhance operations, resolve problems quickly, and improve adherence to deadlines. The following response illustrates this finding:

Respondent 5: *“The utilisation of technology makes it easier for manufacturers to meet production deadlines.”*

It was also noted that technologies have advanced to the point that operations that previously required large amounts of human effort and time could now be completed substantially more quickly. Respondents 8 and 10 stated that the use of technology has enabled work that was previously done by 20 people or took days to complete to be completed in a day.

It was also noted that adopting technology not only increases operational effectiveness and productivity but also gives organisations the ability to lessen their dependency on on-site employees and drastically lower labour costs. The following responses illustrate this finding:

Respondent 5: *“You know the nice thing about the advancement of technology is that you can now send a command from a remote area your machinery does the work”.*

Respondent 3: *“The use of cloud service has what we call a centralised your data base that allows teamwork.”*

These findings are in line with those of previous studies that have found that incorporating technology into the operations of small manufacturing businesses transforms them significantly (Jeza and Lekhanya 2022). The use of technology by manufacturing SMEs fosters and drives creativity and adaptability and facilitates improved performance (Makanyeza *et al.* 2023). It can therefore be concluded that the use of technology to simplify and enhance tasks has become exceedingly crucial for manufacturing SMEs because it aids them in improving efficiency and achieving greater productivity.

6.3.2.2 Subtheme 2: Improved competitiveness

When asked to share their experiences regarding the benefits of ICT adoption, respondents indicated that manufacturing SMEs had been able to improve their competitiveness through the deployment of ICT and the use of marketing strategies. The following responses illustrate this finding:

Respondent 10: *“Technology enables manufacturers to respond to customer needs and become more competitive.”*

Respondent 5: *“Apps such as WhatsApp Business to track deliveries and ensuring that your product reach your customers in time, and you get feedback same time”.*

However, one respondent indicated that most manufacturing SMEs did not use ICT-based marketing strategies.

Respondent 7: *“Advertising and marketing can be expensive, and most manufacturing SMEs rely on word of mouth or the use of pamphlets to market themselves.”*

Studies conducted by Putra and Darmawan (2022) and Etim and Daramola (2023) found that the use of ICT by manufacturing SMEs effectively promoted their brands and engaged customers, which resulted in a competitive advantage over other businesses. However, due to a lack of awareness of the potential of ICT to enhance productivity and competitiveness, small manufacturing businesses frequently overlook the benefits of using helpful technologies (Mady *et al.* 2023; Polisetty, Sowmya and Pahari 2023). Marketing strategies play a vital role in enabling small manufacturing firms to promote their business and build lasting relationships with their customers (Omoruyi and Makaleng 2022).

6.3.3 Theme 3: Factors influencing ICT adoption

The intricate correlation between the level of ICT adoption readiness in manufacturing SMEs and the effective adoption of technology in such firms is crucial in the current business climate. The factors influencing ICT adoption that emerged from the interviews with the IT experts are categorised into six subthemes: ICT adoption readiness, security issues, financial implications, education and training, attitude towards ICT use, and availability of resources.

6.3.3.1 Subtheme 1: ICT adoption readiness

When asked to share their experiences regarding factors influencing ICT adoption, respondents indicated that they perceived manufacturing SMEs as largely underprepared for technology adoption. The following responses illustrate this finding:

Respondent 10: *“The effective implementation and usage of technology is dependent on manufacturing SMEs level of preparedness.”*

Respondent 6: *“You know, one of the most important things that contributes to the high levels of underpreparedness of SMEs for technology adoption is their reluctance to unlearn their old habits, you sometimes find owners that tell you that why change something that is not broken, basically meaning if the traditional practices still work then why waste money you don’t have on the adoption of technology.”*

Respondent 3: *“The effective use technology requires that you first understand the language of programming used in the world of 4IR, like python java script and business logic which is used to do transactions.”*

It was also noted that in addition to a basic understanding of how a particular digital system works, readiness for ICT adoption requires basic knowledge of computer usage and sourcing information from the Internet. The following responses illustrate this finding:

Respondent 5: *“You will be amazed that there are SMEs that prefer the old way of running the business simply because they lack the basic computer skills and that further worsens the level of preparedness for technology adoption.”*

Respondent 9: *“There are small business owners who do not even know how to turn on a computer let alone type, saving documents, going online and downloading documents from the internet”.*

The responses suggest that the unpreparedness of manufacturing SMEs for ICT adoption is associated with a lack of digital culture in small manufacturing businesses. Resistance to change was also identified as a hindrance to technology adoption, as manufacturing SMEs saw no value in changing the procedures and methods on which they had relied in the past.

Ngobe (2023) cautions that the absence of ICT in small manufacturing businesses can lead to inefficiency, decreased productivity, a lack of innovative thinking, difficulties in adapting to industry changes, and limited longevity. In addition, the absence of real-time data analytics tools forces manufacturing SMEs to continue employing out-of-date or inadequate data, which results in flawed decision making.

6.3.3.2 Subtheme 2: Security issues

When asked to share their experiences regarding factors influencing ICT adoption, respondents indicated that ICT adoption is hindered by security vulnerabilities

associated with the adoption of technology. The following responses illustrate this finding:

Respondent 3: *“If your system was poorly developed it makes your firm to be vulnerable to hackers”.*

Respondent 9: *“You know as much as the adoption of cloud computing give you the benefit of your data being stored on the cloud it can also be susceptible to hackers because your system is controlled by third parties.”*

It was noted that outsourcing of technology-related services can result in manufacturing SMEs losing control over crucial procedures, as illustrated by the following response:

Respondent 5: *“While still on the issue of data security, small business managers tend to be reluctant to acquire technology via third party simply because what happens if the provider ceases to operate and maybe your system is due for maintenance.”*

It was also noted that a strategic decision to centralise technological systems might result in complications, as illustrated by the following response:

Respondent 3: *“There is what we call the centralisation of a data base which is good but, that on its own can present issues, let me make an example, the centralisation of a system allows that multiple people within the organisation to access it, but now here is the tricky part if one of the users connects and for some reason there is an error the whole system shuts down meaning other users cannot access it.”*

The use of anti-virus and encryption software was recommended to protect SMEs against hackers, as illustrated by the following response:

Respondent 8: *“There are softwares that SMEs can use like penetration system, how that works is that it continuously checks for vulnerabilities in the system. Also, the vulnerability check helps ascertain whether a user is not utilising the same password for longer periods of time which makes them susceptible to hackers.”*

A study conducted by Du Plessis (2022: 141) found that entrusting crucial technological services to outside parties can present challenges for manufacturing SMEs, whose reputation frequently depends on the quality of service provided. To implement outsourcing successfully, manufacturing SMEs should conduct thorough research, develop solid outsourcing agreements, and have in place efficient risk management plans (Abed 2020: 4).

6.3.3.3 Subtheme 3: Financial implications

When asked to share their experiences regarding factors influencing ICT adoption, respondents indicated that despite the encouraging possibilities presented by the adoption of technology, manufacturing SMEs are often deterred from adopting technology by the significant financial ramifications of doing so. The following responses illustrate this finding:

Respondent 1: *“I believe that even though there are various high-tech solutions that these small businesses can employ the problem is that they are working on a tight budget.”*

Respondent 9: *“One thing you should know is that for small businesses especially those who are resource constrained, the thought of having to set aside money for constant technology updates or acquiring technical support is a contributing factor to non-adoption of technology.”*

It was noted that the cost of acquiring new machinery is particularly challenging for manufacturing SMEs, as illustrated by the following response:

Respondent 5: *“Depending on the knowledge small businesses have, it is cheaper to acquire machinery in a modular fashion, for example they can purchase the first set of machinery and then building up on it until they have a complete line.”*

While modular machinery can be easily installed, uninstalled, and moved around in the production environment to adjust to changing demands or needs (Maganha, Silva and Ferreira 2019; El Zant *et al.* 2021: 109), exorbitant installation expenses, operational costs, and a lack of internal maintenance skills are major factors that contribute to the high cost of adopting new technology (Hasheela-Mufeti and Smolander 2017: 14). From the perspective of the TOE framework, which was discussed in Section 3.1.2 above, the acquisition and maintenance costs of new technologies and their adaptability to existing systems and expertise are significant issues in an SME’s technology environment (Olutoyin and Flowerday 2016: 4). In light of this, financial literacy is crucial to the sustainability of manufacturing SMEs (Ye and Kulathunga 2019: 4). A study conducted by Mustafa and Yaakub (2018: 58) uses the DCT, which was discussed in Section 3.1.3 above, to show that technological advancement and innovation improve the financial performance of manufacturing SMEs.

6.3.3.4 Subtheme 4: Education and training

When asked to share their experiences regarding factors influencing ICT adoption, respondents indicated that the success, growth, and adaptability of manufacturing SMEs are strongly influenced by the educational background and technical skills of their managers. The following response illustrates this finding:

Respondent 1: *“I do believe that training will always be a necessity when adopting new technology, but it varies as to how tech savvy are you as a manufacturer.”*

It was noted that education provides the employees of manufacturing SMEs with the fundamental knowledge needed to comprehend the intricacies of contemporary technologies, as illustrated by the following response:

Respondent 9: *“I think it is important to note that in addition to being illiterate, some manufacturing SMEs cannot even read basic English which makes it hard for them to comprehend basic software commands. But again, that cannot be an excuse because, depending on the proactiveness of the SME managers, these days service providers do offer assistance through agents on WhatsApp for a limited period of time where manufacturers can get further assistance in their preferred language.”*

While a study conducted by North, Aramburu and Lorenzo (2020) found that employee empowerment through education enables manufacturing SMEs to continue being competitive in a market that is rapidly changing by enabling them to adapt to new and emerging technologies, the following responses indicate that a lack of education continues to impede the adoption of technology by manufacturing SMEs.

Respondent 8: *“From my observation manufacturing SMEs still lack basic education and not to mention technical knowledge on how to use technology”.*

Respondent 4: *“I truly believe that SME are not skilled enough to consider automation and finding other tools to reduce the complexity of the technology usage.”*

It was noted that continuous training is necessary for SMEs to keep abreast of the latest technological trends and advancements, as illustrated by the following response:

Respondent 5: *“Well, what I can say is that training is the basis of all operations, so you cannot run away from providing training for your staff or upskilling them to ensure they’re well versed in using ICT...whenever you introduce a new technology training will always be required because not training your employees can lead to employees malfunction that would cost you more than the purchasing price.”*

However, the findings of this study indicate that manufacturing SMEs have failed to provide ongoing training that equips their staff with the knowledge and skills required to navigate the digital realm.

While effective management skills and education can enhance managers' understanding of new technologies (Zahra *et al.* 2021: 176), a study conducted by Mukhuty, Upadhyay and Rothwell (2021: 2071) asserts that there is a significant skills gap which makes it difficult for SMEs to innovate.

6.3.3.5 Subtheme 5: Attitude towards ICT use

When asked to share their experiences regarding factors influencing ICT adoption, respondents identified complexity as a factor that influences manufacturing SMEs' attitude towards accepting new technologies.

Respondents 6 and 9 believed that the negative attitude towards technology adoption by SMEs was as a result of the perceived difficulty of using new technologies, and that many small business owners strongly believe in using their old systems.

However, it was also noted that this challenge could be addressed by means of training, as illustrated by the following response:

Respondent 10: *"It depends on the technology/software adopted, sometimes a simple orientation on use of technology or software provided by the service provider makes a difference."*

The findings of this study demonstrate a direct link between manufacturing SMEs' attitudes towards technology adoption and the PEOU of technologies. The TRA, which was discussed in Section 3.1.5 above, supports the fundamental claim that technology adoption is hindered by pre-existing expertise, preferences, and pre-existing attitudes (Palani *et al.* 2022: 2).

6.3.3.6 Subtheme 6: Availability of resources

When asked to share their experiences regarding factors influencing ICT adoption, respondents indicated that resource availability affects the extent to which ICT is adopted.

Respondents 4 and 9 noted that depending on the type of technology or software, some technologies only require a laptop and Internet access, while others require more extensive ICT infrastructure. The following response illustrates that the adoption of technologies does not always require extensive resources:

Respondent 8: “For SMEs that utilise cloud computing, Microsoft Azure enables them to access cloud services without any infrastructure requirements...For businesses that utilise Power BI software, all they need to have is Microsoft licensing in order to access to power platform so they can use features such as cataloguing their work”.

From the perspective of the TOE framework, a solid technological infrastructure is required for improved performance and increased production (Cherian, Shanmugam and Kumaran 2019: 60). However, a lack of adequate financial resources and access to digital tools continues to hinder the ability of manufacturing SMEs to leverage technology (Kumar, Raut *et al.* 2022). Shang, Lang and Vragov (2022) argue that by embracing free tools and open-source software, small manufacturing businesses can elevate their operations and enhance productivity without incurring substantial software costs.

6.3.4 Theme 4: Potential complications of ICT adoption

The incorporation of ICT into the operation of manufacturing SMEs has potentially unpredictable consequences. The potential complications of ICT adoption that emerged from the interviews with the IT experts are categorised into three subthemes: integration issues, the impact of power outages and loadshedding, and the impact of COVID-19.

6.3.4.1 Subtheme 1: Integration issues

When asked to share their experiences regarding the outcomes of ICT adoption in manufacturing SMEs, respondents highlighted the importance of a comprehensive understanding of the integration process in enabling manufacturing SMEs to effectively plan how technology aligns with their overarching objectives, as illustrated by the following response:

Respondent 10: *“Technical knowledge is often necessary for the integration of new technologies with current systems and for the customisation of them to meet specific company goals.”*

It was noted that integrating new technologies with a firm’s existing technologies is a complex process which disrupts operations if done incorrectly, as illustrated by the following response:

Respondent 6: *“The disruption of business operations occurs when technology is not appropriately integrated.”*

It was also noted that the inability to strategically plan for technology integration is an issue that requires more attention in manufacturing SMEs, as illustrated by the following response:

Respondent 5: *“What I have observed over the years is that SMEs do not adequately plan for the integration of new technologies, given that it would require more care to be effectively integrated”.*

Studies conducted by Eze *et al.* (2019: 582) and Dube, Van Eck and Zuva (2020: 207) assert that the compatibility of ICT applications with current organisational systems influences the feasibility of their integration. It can therefore be concluded that recognising the importance of the compatibility of new technologies with other systems and processes facilitates effective ICT integration in manufacturing SMEs and consequently enables them to respond and adapt quickly and effectively to changes.

6.3.4.2 Subtheme 2: Impact of power outages and loadshedding

When asked to share their experiences regarding the outcomes of ICT adoption in manufacturing SMEs, respondents indicated that frequent power outages hinder the effective utilisation of technology and hamper the productivity of manufacturing SMEs, as illustrated by the following response:

Respondent 5: *“There is no use buying into the use of technology if the firm does not have a backup plan as to how will the load shedding impact on the operations of the business.”*

It was noted that additional costs resulting from load shedding exacerbate the reluctance of manufacturing SMEs to adopt technology, as illustrated by the following response:

Respondent 8: *“As much as we ought to adapt to the ever-changing technological advancements it becomes futile to adopt technology without the consistent provision of electricity.”*

A study conducted by Sheik and Kader (2022: 7) emphasises that affordable and reliable access to power, high-speed Internet connectivity, and devices are all requirements for participating in the digital economy. Manufacturing SMEs in South Africa lack access to these resources and suffer the most severe income losses as a result of load shedding, which alters the way in which operational decisions are made (Botha 2019: 28).

6.3.4.3 Subtheme 3: Impact of COVID-19

When asked to share their experiences regarding the outcomes of ICT adoption in manufacturing SMEs, respondents indicated that the COVID-19 pandemic had exacerbated the preexisting difficulties faced by manufacturing SMEs. While many manufacturing SMEs in KZN were forced to shut down as a result of the trade restrictions, others were enabled to continue operating by the technologies they had adopted, as illustrated by the following response:

Respondent 9: *“If you remember well during COVID the government imposed a hard lockdown which resulted in some SME shutting down for good as they could not trade or make profits, only those small businesses that had adopted technology could continue with their operation online.”*

It was noted that not many SMEs that were affected by the harsh realities of the pandemic had benefitted from the provision of COVID-19 relief funds by the government, as illustrated by the following responses:

Respondent 2: *“Even though there was COVID relief funds intended to assist small businesses, very few SME benefitted, and this was as a result of stringent application requirements.”*

Respondent 10: *“You know some SMEs were not financed merely because they were not clued up about how to access the government assistance.”*

The outbreak of COVID-19 in South Africa led to supply chain complications, which resulted in loss of revenue and massive job losses (Ikwegbue *et al.* 2021: 277). However, a study conducted by Joseph and Dhanabhakym (2022) found that after the pandemic, a number of small businesses considered incorporating technology into their functioning.

6.4 Summary

This chapter has analysed, interpreted, and discussed the data that was gathered from IT experts in the commercial industry through interviews. The qualitative data analysis involved the identification, examination, and interpretation of patterns and themes in the textual data obtained from the interviews. This process involved assessing the data in the context of the research questions, making connections between the data and the research questions, and drawing on the findings of previous studies that supported the findings of the data analysis. This provided a wider view of the subject matter.

The overall findings of the data analysis highlighted the complexity of technology adoption in manufacturing SMEs. Although many challenges remain, technology has the potential to transform the manufacturing sector. By leveraging the power of technology, manufacturing SMEs can increase efficiency in their operations, boost competitiveness, and survive in the current technological landscape with effective investments, collaborative agreements, and an emphasis on human resources development.

In addition, the analysis showed consensus between manufacturing SMEs and IT experts with regard to the ongoing issues that plague the manufacturing sector. These issues include a lack of education, a lack of funding, a lack of government assistance, a lack of investment strategy, a lack of awareness of available technologies, and a lack of infrastructure, which was exacerbated by the looting and flooding that took place in KZN between 2020 and 2022. The integration of new technologies with existing technologies, the impact of power outages, and the impact of the COVID-19 pandemic are also major factors that impede technology adoption in the manufacturing sector. Therefore, manufacturers need to be aware of these factors and take the necessary steps to ensure that technology adoption is implemented in the most efficient manner possible.

It was also noted that the COVID-19 pandemic resulted in a major change in how business activities are conducted. This has required small businesses in the manufacturing sector to become more technologically aware and to adopt digital transformation strategies. This in turn has pushed the boundaries of innovation, which has led to the emergence of new technological solutions and products. It was also noted that businesses have become more agile and flexible as a result of the pandemic, which has enabled them to adapt quickly to new circumstances, to remain competitive, and to take advantage of new opportunities. As people have had to find new ways to generate income and support their families, a new wave of entrepreneurs has emerged as a result of the pandemic. This has resulted in the emergence of new businesses and products and has thus provided much-needed stimulus to the economy of KZN.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The previous two chapters analysed and interpreted the data collected in the empirical study. Chapter Five assessed both the quantitative data and qualitative data that were gathered through questionnaires that were distributed to managers of manufacturing SMEs, and Chapter Six assessed the qualitative data that were gathered through interviews with IT experts. In addition, these chapters provided justification for the relevance of the results to the field of study and established conceptual connections between the findings of this study and the body of knowledge.

This chapter summarises the main findings obtained from both the quantitative and qualitative phases of the study in light of the study's objectives. In addition, the chapter makes recommendations based on the practical implications and significance of these findings and presents a framework to provide practical guidance for the adoption of 4IR technologies by manufacturing SMEs in KZN. Finally, the chapter identifies areas for further research based on the results of this study.

7.2 Discussion of key findings

This section discusses the overall findings of this study in light of the objectives of the study.

7.2.1 Objective One: To identify the ways in which 4IR technologies are used in manufacturing SMEs in KZN

This subsection examines the implementation of technologies by small manufacturing enterprises with regard to the creation of products, the provision of timely and accurate information for decision making, and the satisfaction of customer needs and expectations.

7.2.1.1 Creation of new products and services

While manufacturing SMEs in developed countries have made significant progress in adopting technologies for manufacturing purposes, those in South Africa have been found to be slower to adopt such technologies (Mahdiraji *et al.* 2023; Matsoso 2023). In this study, the quantitative data showed that 64.4% of SMEs in the manufacturing sector in KZN had not adopted technologies that facilitate product creation. This highlights a significant disparity between the intended potential of technology and the actual experiences of manufacturing SMEs in KZN in harnessing the capabilities of technology to enhance their product creation endeavours.

The qualitative findings from the IT experts indicated that small manufacturing enterprises, especially those that are newly established, opted for less expensive ICT solutions to support the sales process, while more established manufacturing SMEs employed costlier ICT techniques that enhance product advancement.

The divergent viewpoints of IT specialists and SMEs indicate a variety of approaches to technology adoption in the manufacturing industry. The inferences made from the data point to issues regarding the perceived usefulness of technologies for product creation. Such issues are as a result of the tendency of manufacturing SME managers who are accustomed to traditional methods to avoid the potential disruptions or difficulties of adapting to new technologies for product creation.

7.2.1.2 Provision of timely and accurate information for decision making

The use of ICT enables manufacturing SMEs to better monitor their operations, optimise processes, and address problems before they become major issues (Mhlongo *et al.* 2023). However, this study's quantitative findings showed that 80.8% of manufacturing SMEs in KZN believed that their current technologies had failed to facilitate the supply of more rapid and precise data for decision making. This failure can be attributed to various factors, including outdated technology infrastructure and insufficient bandwidth. These findings indicate that with the advancement of technology, older systems become less efficient in delivering timely and accurate

information, and that that the functioning and competitiveness of manufacturing SMEs in KZN are hindered by the province's technology infrastructure.

7.2.1.3 Satisfaction of customer needs

The strategic implementation of technology and its integration across different areas of a business have been shown to greatly enhance customer satisfaction (Njomane and Telukdarie 2022). However, this study's quantitative data showed that 83.5% of manufacturing SMEs in KZN did not believe that the technologies they employed were a significant component in fulfilling consumer demands and expectations. These findings can be attributed to a failure to adopt efficient online systems such as digital payments, online ordering, and simplified payment methods.

The qualitative findings indicated that manufacturing SMEs struggled with the concept of technology adoption because they preferred using traditional methods to conduct their operations. This implies that KZN's manufacturing SMEs remain incapable of rapidly adjusting to the ever-changing needs of customers in a market that is becoming progressively digital and highlights the urgency of transforming approaches to technology adoption within the manufacturing sector.

7.2.1.4 Summary of key findings

The first objective of this study was to identify the ways in which 4IR technologies are used in manufacturing SMEs in KZN. The empirical study found that there was no one-size-fits-all strategy for technology adoption in manufacturing SMEs in KZN, and that SMEs had used a variety of approaches and perspectives in their pursuit of improving the product development process through technology. The results showed that although a sizable majority of SMEs had embraced technology, this had not resulted in significant improvements in the product development process. Despite the emphasis by various scholars on the perceived benefits of ICT in providing more timely and accurate information, the findings of this empirical study clearly show that a deficiency still exists in the ability of SMEs to synchronise their operations with the evolving preferences of customers in the digital market, which has led to a failure to effectively utilise technology for customer engagement.

7.2.2 Objective Two: To assess the benefits of adopting 4IR technologies in manufacturing SMEs in KZN

Adapting to the changes resulting from the 4IR and harnessing 4IR technologies are essential for SMEs to succeed in the manufacturing industry in KZN. This subsection examines the role of ICT in helping manufacturing SMEs coordinate their activities at regional, national, and international levels and development of new and complex partnerships. In addition, it examines the role of technology in reducing costs and stimulating productivity and growth. Lastly, it focuses on the role of 4IR technologies in assisting manufacturing SMEs in KZN to remain competitive and improve their financial performance.

7.2.2.1 Regional, national, and global coordination of activities

ICT offers manufacturing SMEs unprecedented levels of accessibility and convenience, as well as the opportunity to conduct business activities more efficiently, accurately, and cost-effectively (Haleem *et al.* 2023; Nkofu 2023). The qualitative findings of this study indicated that technologies such as cloud-based systems and digital databases can enable manufacturing SMEs to access necessary information instantaneously and from any location. However, only a minority of the SMEs in this study (21.4%) believed that the technologies they had adopted had offered them the opportunity to trade outside of KZN.

These findings are a clear indication that majority of manufacturing SMEs in KZN have unrealised potential to access international markets. In addition, these findings demonstrate that the adoption of technology is not uniform across manufacturing SMEs in KZN, which raises concerns about possible impediments to technology adoption. If left unattended to, such impediments can result in missed opportunities, decreased customer satisfaction, and hindered growth and competitiveness for businesses. These findings also point to a possible digital divide among KZN's manufacturing SMEs, with the minority benefitting from technology use.

7.2.2.2 Cost reduction, improved productivity, and increased growth possibilities

The increasing utilisation of digital solutions has provided manufacturing SMEs with the opportunity to optimise their operations, save costs, and leverage newly acquired capabilities to drive sustainable, long-term growth (Masabo 2021; Makuwe 2021). When properly integrated, digital technologies provide access to a range of previously unattainable possibilities that include, but are not limited to, cost savings and operational simplification. However, the quantitative data gathered in this study indicated that 58.6% of manufacturing SMEs in KZN did not believe that the technologies they had implemented had lowered their expenses or boosted their productivity. This can be attributed to a variety of factors, including the type of technological tools used by these SMEs and how effectively they were integrated. These findings suggest that a more thorough analysis of the digital integration procedure is required, as well as an understanding of the reasons why a significant number of participants did not realise the expected increases in productivity and cost savings. Although the results do not refute the possibility of digital technologies being beneficial, they highlight the need for SMEs to thoroughly evaluate their current circumstances before implementing new technologies.

The qualitative findings point to organisational factors in SMEs, such as a lack of awareness of relevant technologies that improve productivity, as a cause for concern. A lack of technological awareness implies forfeited possibilities, constraints in the marketplace, and resistance to innovation. Failure to recognise and respond to technological advances will negatively impact the long-term profitability and sustainability of manufacturing SMEs.

7.2.2.3 Competitiveness and improved financial performance

Through strategic utilisation of technology, small manufacturing businesses can gain a competitive edge, optimise their workflow, and ultimately maximise their financial gains in the rapidly changing digital realm (Butt 2020; Sibiyi 2023). However, the quantitative results of this study showed that, despite the potential benefits of technology, a significant majority (74.7%) of managers of manufacturing SMEs believed that the technologies deployed in their firms had not fulfilled their anticipated

role in improving the competitiveness of their firms. These findings point to a difference between managers' impressions of technology and the actual results of technology on competitiveness. This can be attributed to challenges encountered by managers of manufacturing SMEs with regard to the selection, adoption and implementation of technologies.

The qualitative findings indicated that SMEs' ability to leverage the Internet enables them to target a larger customer base and boost their financial gains through the sale of goods and provision of services. This is a clear indication that the competitiveness of manufacturing SMEs is significantly hindered by an inability to leverage technology to expand customer reach and to sell products online. Failing to keep pace with advancements in technology makes it challenging for manufacturing SMEs to compete in a market that places great importance on easy accessibility and online visibility. Moreover, the attention given to utilising the Internet for customer interaction and online business operations highlights the significance of digital strategies for the success of manufacturing SMEs.

7.2.2.4 Summary of key findings

The second objective of this study was to assess the benefits of adopting 4IR technologies in manufacturing SMEs in KZN. The findings indicated that manufacturing SMEs encountered difficulties in leveraging technology for international market expansion, which prevented them from reaching a larger market and made it more difficult for them to engage in international trade. The findings also indicated that the technologies used by manufacturing SMEs did not provide them with cost savings, increased efficiency, or expanded growth opportunities. Therefore, these SMEs had not realised the anticipated gains in cost and operational efficiency, as well as overall business expansion, from the technologies they had implemented. This points to a need for subsequent studies to focus on understanding the particular obstacles faced by manufacturing SMEs in utilising technology to expand their global reach. This can be achieved by examining the barriers that prevent manufacturing SMEs from expanding their market reach and participating in global trade despite their utilisation of technology.

The findings also indicated that the results of technology adoption were impacted by the extent to which manufacturing SMEs integrated and customised technologies to fit their existing processes. This demonstrates that technology can, in fact, produce the desired results, depending on how it is integrated into a firm's operational procedures.

With regard to competitiveness and improved financial performance, the findings indicated that a small number of SMEs were satisfied with their capacity to utilise the technologies they had adopted to enhance competitiveness and elevate their economic potential. This demonstrates that some SMEs have found technology useful in achieving their financial objectives and maintaining a leading position in their respective marketplaces.

7.2.3 Objective Three: To assess the barriers to adopting 4IR technologies in manufacturing SMEs in KZN

This subsection identifies the barriers that manufacturing SMEs in KZN confront and highlights important issues affecting technology adoption. One significant obstacle that threatens the potential prosperity of manufacturing SMEs is the high cost of adopting new technologies. Another obstacle to the effective deployment of 4IR technologies is the lack of a suitable infrastructure to facilitate their adoption. In addition, the inherent complexity and incompatibility of 4IR technologies prevents them from being successfully adopted within the SME sector. Finally, the vulnerabilities associated with 4IR technologies raise concerns about cybersecurity which influence the reluctance of manufacturing SMEs in KZN to adopt new technologies. This study investigates the complex web of challenges presented in the questions that were posed to manufacturing SMEs in KZN in order to shed light on the obstacles they encounter in harnessing the full potential of technology.

7.2.3.1 Cost of technology adoption

The quantitative findings of this study show that the majority of manufacturing SMEs in KZN (51.3%) believed and a further 35.2% strongly believed that their success had been hampered by the substantial costs of adopting new technologies. This is in line with the qualitative findings, which indicated that the adoption of technology results in

additional costs for ongoing maintenance and upgrades, which significantly burden manufacturing SMEs that are already financially constrained. Hence, SMEs that lack funds may face difficulties as a result of the significant financial strain that these expenses cause. Studies conducted by Nyathi (2022) and Mkhwanazi (2023) found that manufacturing SMEs operate on tight budgets and may struggle to afford the initial investment required to adopt advanced technology systems. The empirical findings of this study also demonstrate that the economic circumstances in South Africa have resulted in heightened interest rates, which have led to SMEs refraining from embracing new technologies as they consider them to be a significant financial risk. This is because higher borrowing rates result in a lengthier loan repayment duration for SMEs. The findings of this study indicate that the adoption of ICT is impeded by a variety of factors in addition to financial issues, including allocation of resources, operational effectiveness, a lack of expected income in the near future, and economic sustainability. Acknowledging these challenges highlights the significance of a holistic approach in assisting SMEs to manage the expenses of adopting new technologies in order to enable them to thrive in their respective industries.

7.2.3.2 Lack of infrastructure to support technology adoption

The quantitative findings of this study indicated that the majority of manufacturing SMEs in KZN (93.4%) believed that a lack of reliable infrastructure to support new technologies had made it more difficult to successfully implement new technologies. For SMEs, in which efficiency is critical and resources are limited, the implications of these findings extend beyond the operational domain and impact multiple facets of the enterprise.

It can be inferred from the qualitative results that SMEs operating in rural areas and developing regions have encountered challenges in utilising technology due to poor Internet infrastructure. These findings resonate with those of studies conducted by Akoh (2023) and Etim and Daramola (2023), who established that a lack of availability and affordability of supporting infrastructure, such as power and transportation, can hinder technology adoption in SMEs. As noted in Section 6.4 above, the damage caused by floods to infrastructure has negated the efforts made by SMEs in KZN to adopt technology. From the perspective of the TOE framework, a solid infrastructure

is vital as it enables manufacturing SMEs to effectively integrate and use technology in their operations.

The quantitative results highlight the importance of infrastructure availability in enabling seamless communication, data management, and system integration, all of which are essential for effective technology adoption. The qualitative results provide a broader view of the above challenges by emphasising that SMEs operating in developing and rural locations encounter particular challenges when adopting technology, which mostly result from inadequate Internet connectivity. This underlines the reality that the infrastructure deficit is not consistent throughout every region and could have a disproportionately detrimental effect on enterprises in rural or less developed areas. In order to create an environment in which SMEs, no matter where they are located, can effectively employ technology and stay viable in the current business environment, it is necessary to address the above-mentioned infrastructure deficiencies.

7.2.3.3 Incompatibility and complexity

The quantitative findings of this study indicated that the majority of manufacturing SMEs (61.3%) strongly believed and a further 28.7% believed that the perceived complexity of adopting and using new technologies had hindered technology adoption in their firms. The perceived challenge of implementing and utilising new technology is problematic as it potentially impedes technology adoption and exacerbates the reluctance of manufacturing SMEs to adopt new technologies.

The qualitative findings indicated that discrepancies between new technologies and existing operational practices present obstacles and result in manufacturing SMEs perceiving new technologies as challenging. The complexity here is not only in the technological aspects, but also in the degree to which the technology complements and improves existing business processes. Inadequate hardware, inadequate networking capabilities, and software incompatibility all limit the seamless incorporation of new technologies. In addition, a lack of support makes it challenging for manufacturing SMEs to implement new technologies and also results in compatibility issues. Furthermore, challenges with the intricacy and incompatibility of

new technologies are exacerbated by the lack of a clear technology strategy. The lack of a clear plan for aligning technology adoption decisions with a firm's business goals could result in a disjointed adoption strategy and possible conflict between the adopted technology and organisational requirements. From the perspectives of the TAM and the TOE framework, complexities associated with new technologies can create feelings of uncertainty and anxiety that cause SMEs to perceive the technologies as overwhelming.

These findings resonate with those of studies conducted by Kruger and Steyn (2023) and Mhlongo and Daya (2023), who found that while technological advancements offer numerous benefits, the successful adoption of 4IR technologies by manufacturing SMEs is hindered by incompatibility and complexity of the technologies. It can therefore be concluded that, if left unresolved, the perceived complexity of new technologies will exacerbate resistance towards their adoption, as manufacturing SMEs may be ill-equipped to deal with complexities presented by these technologies.

7.2.3.4 Security vulnerabilities

Security vulnerabilities of 4IR technologies can have a significant impact on resistance to technology adoption. Studies conducted by Mkhathwa and Mawela (2023) and Ndulu et al. (2023) found that the potential for increased cybersecurity threats is one of the primary concerns surrounding the deployment of 4IR technologies.

The quantitative findings of this study indicate that the majority (90%) of manufacturing SMEs in KZN believed that vulnerabilities associated with new technologies had contributed to their reluctance to adopt such technologies. These results are consistent with those from the qualitative phase, which showed that as more devices and systems are networked and interchange data, the danger of cyberattacks and security breaches rises. The convergence of findings from the two samples clearly shows that manufacturing SMEs face a major obstacle in the form of technological vulnerabilities, which contributes to their apprehension of new technologies and their resistance to adopt such technologies. In addition, this indicates that SMEs generally struggle to adopt and incorporate new technologies into their daily operations. Studies conducted by Ariffin et al. (2023) and Raska and Bitzinger (2023) assert that the

potential for privacy invasion and unethical use of data can act as a deterrent to the adoption of 4IR technologies. The qualitative results also indicated concerns about how personal information is collected, stored, and used by these technologies. Such concerns can erode trust in the implementation of these technologies, which results in resistance from users who prioritise their privacy.

7.2.3.5 Summary of key findings

The third objective of this study was to assess the barriers to adopting 4IR technologies in manufacturing SMEs in KZN. The empirical findings clearly show that manufacturing SMEs in KZN have continued to face challenges in incorporating technological solutions into their business processes. Challenges related to funding, which include high start-up costs, ongoing maintenance costs, and possible changes to existing financial plans, were identified as being of particular concern.

The availability of infrastructure to facilitate technology adoption was also identified as a challenge. It was apparent that the province of KZN had experienced numerous calamities, including instances of looting and catastrophic floods that seriously damaged the region's pre-existing infrastructure. These events have had far-reaching consequences, especially for manufacturing SMEs considering technology adoption. If infrastructural impediments are not urgently addressed, it will be very difficult for manufacturing SMEs to expand and compete, which will lead to a slowdown in the already unstable economy of KZN.

The complexity and compatibility of technologies were identified as a further challenge. It was apparent that manufacturing SMEs had struggled to identify technologies that could be easily integrated without disrupting their business operations.

Finally, security vulnerabilities were identified as a factor that hampers technology adoption. The findings showed that manufacturing SMEs in KZN lacked the expertise to detect potential threats, which deterred them from adopting technology.

7.2.4 Objective Four: To develop practical strategies for overcoming barriers to the implementation of 4IR technologies in manufacturing SMEs in KZN

This objective was formulated to identify the strategies utilised by manufacturing SMEs to overcome challenges presented by the adoption of 4IR technologies. These strategies include skills development, investment in technology adoption, ensuring security of online activities, and improving collaboration with larger firms.

7.2.4.1 Skills development

The provision of education and training programs that specifically address the skills needed to implement and manage 4IR technologies is crucial for the successful implementation of ICT (Alexander 2022; Mhlanga, D 2022b). The quantitative findings of this study indicated that the majority of manufacturing SMEs in KZN (77%) did not have strategies in place to develop skills related to the implementation of technologies. The lack of such strategies indicates that these SMEs had not taken proactive steps towards narrowing the skills gap among their employees. This adversely affects the ability of SMEs to compete and adapt in an environment that increasingly requires continuous skills development to keep abreast of technological advancements and industry-related changes. The development and implementation of comprehensive skills development strategies require financial investment and dedicated personnel, which are challenges for SMEs with constrained budgets. These findings clearly indicate that the ability of manufacturing SMEs to develop strategic initiatives is hampered by the lack of a blueprint or industry-specific best practices. The lack of a standardised blueprint makes it difficult for these SMEs to handle the intricacies of strategic planning, which in turn impedes their capacity to address significant issues such as a lack of digital skills and firm viability.

7.2.4.2 Investment in technology adoption

If manufacturing SMEs lack a proper investment strategy, they may risk investing in technologies that are not appropriate for their unique requirements or that do not yield a significant return on investment. The quantitative findings of this study indicated that 79.7% of manufacturing SMEs in KZN lacked an investment strategy for the adoption

of emerging technologies. The qualitative findings indicated that SMEs that are already financially constrained find it difficult to commit finances they do not have to adopt new technologies. These findings, which showed that most manufacturing SMEs in KZN had no plans to invest in technology to improve their viability, present a bleak picture. In addition to lost opportunities and diminished competitiveness, the lack of a formal investment plan presents an obstacle to operational effectiveness, creativity, and general flexibility in the constantly changing business environment. Without a clear plan in place, companies may not adequately assess the potential risks and challenges that come with implementing new technologies (Rambaruth *et al.* 2022; Gwala and Mashau 2023). While this study aimed to identify investment strategies for technology adoption that had been developed and implemented, the empirical findings indicated an extensive deficiency of expertise in developing investment strategies for ICT adoption among manufacturing SMEs in KZN. The findings also indicated that due to financial constraints, the majority of manufacturing SMEs had decided to continue with outdated practices rather than investing in new technologies. A comparatively small percentage (19.5%) of SMEs had existing investment strategies for technology adoption; these enterprises may require guidance to enhance the effectiveness of their plans and to improve their ability to manage the challenges of integrating technology into their daily operations.

7.2.4.3 Ensuring security of online activities

SMEs that prioritise cybersecurity are more likely to outperform their competition and appeal to customers who value security (Nkosana 2022). However, the quantitative findings of this study indicated that the majority (83.9%) of manufacturing SMEs in KZN did not have a strategy in place to ensure the security of online activities. The qualitative findings indicated that the lack of a clear plan for online security increases customers' apprehensions about the safety of their data. Consequently, customers are hesitant to engage with a company they perceive as susceptible to cyber-attacks. This results in reduced competitiveness, decreased innovation, and potential damage to an organisation's long-term viability. These findings indicate an alarming lack of preparedness for secure online operations among SMEs in the manufacturing sector. The repercussions of this deficiency are cause for great concern. Without an effective online security strategy, manufacturing SMEs risk being targeted by cyberattacks,

experiencing data breaches, and having their private information compromised. These threats compromise key business operations and lead to significant financial ramifications, negative impact on the firm's image, and failure to comply with regulations. In the long term, cyber-attacks impose a significant financial burden on manufacturing SMEs, which includes data recovery costs, legal ramifications, and compensating affected individuals.

7.2.4.4 Collaboration with larger firms

The quantitative findings of this study indicated that the majority (78.9%) of manufacturing SMEs in KZN did not have a strategy in place to enhance collaboration with other firms. This can be attributed to a lack of awareness of the benefits of collaborating with larger firms and limited access to information about potential opportunities for collaboration. The qualitative findings indicated that SMEs have limited access to networking events or platforms that enable them to connect with larger firms and explore collaboration opportunities. This suggests that small manufacturing businesses are not experiencing the benefits of collaboration with other firms, such as exchanging ideas, sharing resources, generating synergies, expanding their operations, and opening up new markets. Such benefits, particularly from collaboration with larger firms, can help SMEs succeed holistically. The absence of a coordinated approach to collaboration may hinder the growth and competitiveness of manufacturing SMEs. The reluctance of SMEs to develop strategies for collaboration can be attributed to a lack of understanding of collaborative processes, such as approaching potential partners, negotiating contracts, and ensuring mutually beneficial relationships. In addition, SMEs often have limited financial and human resources, which may make it difficult for them to actively pursue opportunities to collaborate with larger firms (Saruchera and Mpunzi 2023). An understanding of these challenges brings further clarity to this study's finding that most manufacturing SMEs in KZN have failed to develop strategies that encourage and implement collaboration with other organisations.

7.2.4.5 Summary of key findings

The fourth objective of this study was to develop practical strategies for overcoming barriers to the implementation of 4IR technologies in manufacturing SMEs in KZN. The empirical study found that a sizeable majority of manufacturing SMEs in KZN had not devised any plans for technology adoption. This has negatively impacted the skill sets of these SMEs and has also resulted in the absence of investment strategies for the adoption of technology. These findings point to a significant deficiency in the strategic planning processes of these SMEs. In addition, they suggest that a sizable proportion of manufacturing SMEs operate at a competitive disadvantage due to a lack of preparedness and foresight in navigating the challenges of adopting new technologies. This competitive disadvantage is exacerbated by the failure of these SMEs to develop plans for collaborative initiatives that could be beneficial to them. Such collaborative initiatives could provide SMEs with valuable insights into the planning processes followed by established firms with regard to the adoption and profitable usage of technologies.

Recommendations to address this objective are presented in the following section.

7.3 Recommendations

In addition to investigating and analysing the status of technology adoption in these SMEs, this study seeks to provide practical recommendations for maximising the potential benefits of 4IR technologies while addressing the unique challenges that exist in the context of KZN. The recommendations presented below are based on a meticulous analysis of the quantitative and qualitative findings of this study. They aim to offer valuable insights and guidance specifically tailored to manufacturing SMEs in KZN. These recommendations also form the basis of a framework for SMEs to enhance their utilisation of technology, which is proposed in Section 7.4.

7.3.1 Creation of new products and services

The literature review in Chapter Two revealed that in developing countries such as South Africa, there is a deficiency in the efficient leverage of technology for the development of innovative products or services. It is therefore vital to gain a deeper

understanding of the role of technology in product creation from the perspective of manufacturing SMEs in KZN.

In order for the adoption of new technologies to effectively lead to the development of new products, it is recommended that SMEs conduct assessments of their manufacturing needs to enable them to maximise their technological investments and enhance their capacity to innovate products. Manufacturing SMEs should evaluate their current capabilities and identify the technology requirements for creating new products or services. This should be carried out either before or during strategic planning periods for new product development projects in order to ensure alignment with the firm's priorities. Given that SMEs generally have financial constraints, it is crucial that manufacturing SME managers prioritise the key areas that have a significant impact on innovation. In addition, it is advisable that SMEs seek assistance from industry associations or utilise government resources to access information and skills. This hands-on approach aids manufacturing SMEs with limited resources in evaluating their technology needs and making strategic decisions for the future.

Open-source design software such as Blender (3D modelling), GIMP (graphics editing), and Inkscape (vector graphics) provide robust capabilities for product design without licensing costs. The use of such tools, in addition to CC, will lead to cost savings and increased efficiency in the product development process.

7.3.2 Provision of timely and accurate information for decision making

In order to integrate technology to meet the unique information requirements of manufacturing SMEs, consideration and analysis of information requirements is recommended in order to determine what information is required, how often it is required, and its applicability for decision making. To effectively consider the data required for decision making, manufacturing SMEs should carefully review their own data internally, including operational information, sales statistics, and manufacturing metrics. Analysing manufacturing metrics will provide feedback on the efficiency of manufacturing procedures. This will help SMEs to identify delays, reduce waste, and raise output levels, thereby optimising resource efficiency and expediting the process of creating new products.

As noted in Section 5.6.2 above, concerns have been raised that manufacturing SMEs lack the knowledge and skills to identify and use technologies that would assist in the provision of timely and accurate information for decision making. It is recommended that manufacturing SMEs consider implementing tools such as data analytics software, Microsoft Power BI, or cloud-based data management systems that can provide real-time or near real-time information for decision-making purposes.

Manufacturing SMEs should ensure that the technologies adopted for data analysis and reporting have user-friendly interfaces that are accessible to decision makers. This will enable decision makers to understand the information quickly and make informed decisions. An example of such a technology is Tableau, which offers an intuitive drag-and-drop interface that can enable manufacturing SMEs to generate powerful representations without requiring a high level of technical knowledge. Tableau evaluates sales data, revenue patterns, and consumer behaviours, which can enable decision makers to better understand customer preferences and enhance their sales strategies.

Additionally, manufacturing SMEs in KZN are advised to regularly evaluate the performance and effectiveness of the adopted technologies in providing timely and accurate information for decision making. This can be achieved by engaging the services of experienced consultants or technology specialists who will develop specific criteria for assessing the performance of a system, including the accuracy of information, the system's reliability, user satisfaction, response time, and alignment with business goals. Engaging the services of such experts will enable managers of manufacturing SMEs to prioritise their operational responsibilities while their business is assessed.

7.3.3 Satisfaction of customer needs

It is recommended that manufacturing SMEs investigate the use of data analytics, market research, customer surveys, and feedback channels to obtain a deeper understanding of what their customers want from their goods and services. This knowledge will enable SMEs to align adopted technologies to consumer needs.

In addition, manufacturing SMEs should use technologies to offer self-service options that enable customers to search for information independently, make purchases, and resolve common issues. Self-service tools such as automated chatbots can provide immediate assistance to customers by addressing queries and assisting with typical issues. Supplying accurate information promptly ensures that customers can quickly and conveniently access dependable assistance.

To enable quick and effective interactions with customers, manufacturing SMEs should also consider implementing applications and tools that increase convenience and decrease customer effort, such as frequently asked questions, self-checkout systems, live chat, social media listening tools, and instant messaging platforms. The use of these platforms enables manufacturing SMEs to respond quickly to customer queries, issues, and comments, thereby showing their commitment to meeting the needs of their customers.

7.3.4 Regional, national, and global coordination of activities

This study recommends the adoption of scalable cloud-based platforms and distributed systems which facilitate seamless coordination across different locations. Leveraging scalable cloud-based platforms and distributed systems provides manufacturing SMEs with increased flexibility, reduces costs, ensures data security, promotes collaboration, and enables remote management. Furthermore, using cloud-based services gives SMEs the flexibility to work from any location, which improves collaboration and encourages effective communication between people in various physical locations.

Manufacturing SMEs should also consider using platforms that enable real-time communication and information sharing, such as project management software, team messaging apps, video conferencing platforms, and document sharing platforms. Such platforms foster efficient collaboration and enhance coordination among different branches or teams, regardless of geographical barriers. Within manufacturing SMEs, coordination issues can be addressed through the use of real-time communication and collaboration tools. Such tools enable centralisation of information and provide instant

updates to support collaboration, effective task management, and informed decision making.

7.3.5 Cost reduction, improved productivity, and increased growth possibilities

Before deciding to adopt a technology, manufacturing SMEs should conduct a thorough cost-benefit analysis to assess the technology's potential impact on business costs, productivity, and growth. This process should involve setting clear goals and standards, determining associated costs, estimating potential gains, projecting return-on-investment timelines, assessing risks and comparing options.

In addition, managers of manufacturing SMEs should engage stakeholders, conduct practical pilot projects, ensure legal compliance, evaluate scalability, and perform sensitivity analysis. Engaging stakeholders ensures that a range of viewpoints are considered, which promotes support and alignment with the objectives of the business. Conducting a practical pilot project will help to identify possible problems before the full deployment of a technology.

7.3.6 Competitiveness and improved financial performance

In order to improve competitiveness and financial performance, it is recommended that manufacturing SMEs focus on being the most budget-friendly option in the market. This will entice customers who prioritise affordability and seek the best-priced deals. In addition to generating higher revenue by offering the most cost-effective options to customers, this will enable SMEs to increase their customer base, maintain customer loyalty, and show their ability to adapt to market changes.

Manufacturing SMEs should establish a differentiation strategy that enables them to compete on the basis of the distinctiveness and calibre of their products. Such a strategy creates a long-lasting and distinctive market position, encourages customer loyalty, and contributes to sustained profitability, regardless of budget limitations. By fostering brand recognition, economic endurance, and adaptability to changing trends, this approach can strengthen an SME's long-term economic potential in a competitive

environment. Despite stringent financial restrictions, this strategic approach can enable SMEs to thrive, expand, and establish a strong financial base.

To succeed in a competitive industry, manufacturing SMEs should employ innovative strategies and creative thinking to distinguish themselves. This will enable SMEs to adapt to customer needs by offering specialised products or services that are in demand. In the long term, SMEs that innovate can become less susceptible to adverse circumstances such as economic downturns and unanticipated difficulties. The capacity of such SMEs for innovation and adaptation can enable them to withstand setbacks and sustain long-term growth.

In addition, manufacturing SMEs should aim to create an environment that encourages innovation and continuous improvement. To accomplish this, it is essential to recognise the significance of leadership in launching new concepts. Managers of manufacturing SMEs should actively encourage and promote innovative initiatives by establishing policies and providing resources that enable their employees to contribute innovative concepts. SMEs in the manufacturing sector should encourage a culture of innovation and failure-based learning, which can be accomplished by motivating their employees to view setbacks as opportunities for development and advancement.

7.3.7 Cost of technology adoption

Expenses linked to technology adoption have been extensively discussed in this study and have been found to contribute to the hesitancy of manufacturing SMEs to adopt technologies.

This study recommends that manufacturing SMEs allocate sufficient resources to technology-related initiatives to increase the probability of their success. By allocating adequate funds and resources, small businesses can overcome barriers such as limited skills, technology, and training. Prudent allocation of funds can enable managers of manufacturing SMEs to acquire necessary skills, ensure effective utilisation of technology, and promptly address any issues.

Manufacturing SMEs should explore government initiatives, grants, and funding programmes that support the adoption of 4IR technologies in manufacturing. Information about possible grants and funding schemes for the use of 4IR technologies may be obtained from the Department of Trade, Industry and Competition directly or via their website. In addition, funding opportunities for innovative projects, especially those involving 4IR technologies, are available to SMEs through the Technology Innovation Agency. As public funding may not always be sufficient, manufacturing SMEs are advised to seek support from private organisations such as Lulalend, which works to expand SMEs in South Africa, and the KZN Growth Fund, which assists various sectors including the manufacturing sector. By accessing public and private funding sources, SMEs can expand their financial resources and establish a strong financial base for technology adoption.

This study also recommends that manufacturing SMEs explore CC as a cost-effective alternative to traditional on-premises infrastructure. Pay-as-you-go models allow SMEs to pay for resources and services based on their actual usage, which minimises wastage and reduces overall costs.

In addition, manufacturing SMEs should consider leasing and financing options provided by technology vendors and financial institutions. Financing options such as equipment loans and technology-specific loans can help SMEs manage cash flow while investing in necessary technology upgrades. Leasing has the potential to enable manufacturing SMEs to access technology without significant upfront costs by spreading expenses over a defined period.

7.3.8 Lack of infrastructure to support technology adoption

This study recommends that manufacturing SMEs determine the critical infrastructure requirements that are necessary to support the adoption of technology. Thereafter, manufacturing SMEs should conduct a comprehensive assessment of the existing infrastructure to identify gaps and areas that need improvement. This assessment should cover aspects such as hardware, software, networking capabilities, internet connectivity, power supply, and data storage. Understanding the current infrastructural limitations will help manufacturing SMEs plan for necessary upgrades or alternative

solutions. Engaging external professionals, particularly for assessing and strategising technology solutions, introduces fresh perspectives and expertise. Such experts can draw on their wealth of experience to provide valuable insight into the organisation's requirements, obstacles, and potential for technological advancement.

A further recommendation is that manufacturing SMEs invest in areas such as telecommunications infrastructure and Internet connectivity in order to foster an environment that is conducive to the adoption of new technologies. A dependable telecommunications infrastructure enhances the effectiveness of operations and facilitates instantaneous communication and data exchange. Reliable Internet connectivity facilitates the use of data analytics, cloud-based applications, and remote monitoring, all of which promote creativity and flexibility. In the long term, such investments will improve operational effectiveness and facilitate the efficient incorporation of new technological advancements.

7.3.9 Incompatibility and complexity

The findings of this study highlight the issue of technology complexity as a hindrance to technology adoption. In order to address this issue, it is recommended that managers of manufacturing SMEs determine the skills and knowledge required by their employees for utilising and managing technology. This can be achieved by engaging in conversations with employees about utilising new technologies, which will assist in identifying issues and developing the necessary competencies to mitigate technological complexities through training.

In addition, manufacturing SMEs should analyse the degree of challenge in the manufacturing process by determining the quantity of steps required, the level of intricacy of each task, and the level of automation. This will help managers to locate bottlenecks, eliminate unnecessary actions, and address any flaws in the system. In the long term, assessing the complexity of the manufacturing process will improve a firm's efficiency, reduce costs, and enhance product quality, thereby enabling it to succeed in a competitive market.

It is also advisable for manufacturing SMEs to consider leveraging standardised technology platforms and solutions such as SAP, Oracle, and Microsoft Dynamics. By eliminating the need to maintain numerous complex systems, such solutions can enable manufacturing SMEs to simplify their IT environment and to make it more manageable and affordable. Standardised solutions often have integrated analytics and reporting capabilities that provide data-driven insights to enhance decision making.

7.3.10 Security vulnerabilities

It is recommended that manufacturing SMEs perform a cybersecurity assessment to evaluate the organisation's current level of security. This will assist in identifying existing deficiencies and potential threats and will enable firms to enhance their security through the implementation of robust security measures such as firewalls, encryption, multi-factor authentication, and regular security audits. In the long term, this will minimise potential consequences of cyberattacks, such as data breaches and downtime, and result in financial savings.

In addition, manufacturing SMEs should regularly provide cybersecurity training to their employees. Such training should emphasise best practices for security and increase awareness of phishing attempts. By providing cybersecurity training, manufacturing SMEs will raise their employees' awareness of security and bolster their defences against cyberthreats. In the long term, this will result in reduced risks, improved security measures, and heightened awareness of cybersafety among all employees.

To prevent security breaches from affecting an entire network, a firm should separate its network into distinct segments by implementing virtual local area networks. This will mitigate the potential effects of an attack by limiting the extent of the security breach and ensuring that vital systems are protected from illegal penetration.

7.3.11 Skills development

It is recommended that manufacturing SMEs conduct a skills assessment to identify skills gaps and areas where training and development are required. Managers of manufacturing SMEs who are considering implementing a new technology should establish precise goals for the technology and be aware of how it will affect operational procedures. Thereafter, managers should interact with employees who will be impacted by the new technology to determine their current skill levels. IT experts should also be consulted with regard to skills requirements related to the adoption of the new technology. After identifying skills deficiencies, specialised training programmes that target the identified skills gaps should be developed and implemented.

The findings of this study indicated that manufacturing SMEs lacked the necessary skills to implement new technologies. To develop skills for the deployment of new technologies, a cooperative and encouraging approach that includes universities, industry specialists, government agencies, and large enterprises is recommended. Government organisations such as SEDA can assist in facilitating access to appropriate training programs and providing financial assistance. Universities can offer specialised courses that are in line with the requirements of the sector. Industry specialists can provide practical insights by conducting workshops. DUT's Centre for Entrepreneurship and Innovation regularly interacts with SMEs and offers mentorship, hands-on training, and access to resources for business development. The University of Pretoria's Gordon Institute of Business Science (GIBS) offers workshops and seminars on SME growth, innovation, and managerial training. Engagement with reputable institutions such as DUT and GIBS will yield positive results for manufacturing SMEs, such as heightened ICT proficiency, more efficient technological integration, greater inventiveness, and heightened competitiveness. Moreover, manufacturing SMEs will be better positioned for profitable growth in an increasingly digitalised business environment by utilising the resources and knowledge offered by these institutions.

Manufacturing SMEs should be aware of the continuously evolving nature of technology and the crucial importance of ongoing skills development in ensuring that

employees remain competent and capable of utilising technologies effectively. In order for manufacturing SMEs to create skills development strategies, it is vital that they keep abreast of technological advancements and changes related to the technologies they use. This can be achieved through engagement with ICT industry publications, conferences, webinars, and professional networks.

In addition, manufacturing SMEs should consider being involved in incubation programmes that provide guidance, support, and hands-on learning opportunities for employees. Such programmes provide access to mentors in the ICT field who can share their knowledge, offer practical advice, and help employees navigate the implementation process. An incubation programme should be started early in the planning stage of ICT adoption in order to ensure that managers possess the necessary skills and understand precisely how technological advances could impact their daily operations. Business incubators in KZN, such as the Durban Chemicals Cluster Incubator and Dube Trade Port, promote sustainability and innovation in the manufacturing sector. The extensive support provided by Dube Trade Port includes facilities, infrastructure, and training. The Durban Chemicals Cluster Incubator is supported by the eThekweni Municipality and functions as a cooperative forum that promotes skills enhancement, assistance with local sourcing, and the start-up of vital manufacturing initiatives to propel industry expansion. In addition, employees directly involved in the integration of ICT should be paired with seasoned mentors as part of the mentorship program. This may entail group workshops, one-on-one mentoring relationships, or a mix of the two. Ultimately, by developing a competent and self-assured workforce, mentorship programs support the success of the ICT adoption process.

7.3.12 Investment in technology adoption

Before developing an investment strategy, manufacturing SMEs should define their long-term business objectives. This includes identifying target markets, understanding customer needs, and setting specific growth targets. All investment decisions should be aligned with business objectives to ensure a coherent and focused approach. In addition to ensuring strategic alignment and targeted resource allocation, aligning investment approaches with clearly established long-term business objectives

improves stakeholder confidence, flexibility, and risk mitigation. This process not only sets the groundwork for resilient, continuous growth in the ever-changing manufacturing sector, but also improves the creditworthiness of manufacturing SMEs.

It is advisable for manufacturing SMEs to explore the possibility of obtaining assets through leasing or hire purchase agreements. By doing so, manufacturing SMEs will be able to gradually acquire assets as they grow and increase in profitability. Such agreements involve making instalment payments over a prearranged period of time, with full ownership of the asset after the purchase price is paid in full. Such flexible financing options enable manufacturing SMEs to successfully manage cash flow and preserve liquidity while acquiring necessary assets.

Manufacturing SMEs should assess their current technological capabilities and identify areas that need improvement or investment. This may involve conducting a technology audit, benchmarking against industry leaders, and considering emerging technologies that can enhance productivity, efficiency, and competitiveness.

In addition, manufacturing SMEs should closely monitor industry trends and conduct market analyses to identify potential opportunities and threats. This information will help SMEs prioritise investment areas and make informed decisions about technology adoption. If there is a growing demand for sustainable manufacturing practices, manufacturing SMEs may prioritise investments in eco-friendly technologies.

7.3.13 Collaboration with larger firms

This study recommends that manufacturing SMEs conduct research and identify larger firms that operate in the same industry or in complementary sectors, including firms that will benefit from their products, services, or expertise. Collaborating with large corporations provides opportunities to utilise cutting-edge technologies and explore innovative methods. Collaboration can enable SMEs to leverage new technologies, improve product quality, optimise production methods, enhance customer service, and reduce costs. Forming partnerships with larger enterprises can provide SMEs with access to new markets and a wider consumer base.

Manufacturing SMEs should identify areas where they can complement the resources or expertise of larger firms. In addition, they should explore opportunities to create synergies and mutually beneficial outcomes. To start this process, manufacturing SMEs should engage with sector-specific seminars, Internet forums, and business meetings where larger enterprises might be present. Participating in such forums allows SMEs to engage in discussions, discover shared interests, and network with potential collaborators. Industry associations, business registries, and online team coordination platforms are likely to assist manufacturing SMEs to locate appropriate partners because they can offer larger firms access to specific markets, specialised knowledge, agility, and innovation. In addition, such engagements can provide an opportunity to influence the future development of technologies based on the specific needs of SMEs.

Manufacturing SMEs should initiate collaboration with larger firms by proposing small-scale or pilot projects. For instance, a manufacturing SME could join forces with another firm to devise and execute a marketing campaign or event aimed at reaching a wider customer base. Analysing the synergy of such marketing endeavours would enable both parties to build rapport and explore possibilities for fruitful cooperation. In addition, small projects provide manufacturing SMEs with opportunities to showcase their capabilities and build a track record for future collaborations.

7.4 Proposed integrated conceptual framework

A bivariate correlation analysis was conducted on the dataset derived from this study to identify correlations between various factors affecting the implementation and influence of 4IR technologies in the manufacturing SME sector in KZN. Table 7.1 below shows the results of the correlation analysis.

Table 7.1: Bivariate correlation analysis

		Correlations			
		Utilisation of technologies	Benefits of the adoption of technologies	Barriers to the adoption of technologies	Strategies for technology adoption
Utilisation of technologies	Pearson Correlation	--			
	N	261			
Benefits of the adoption of technologies	Pearson Correlation	.663**	--		
	Sig. (2-tailed)	0.000			
	N	261	261		
Barriers to the adoption of technologies	Pearson Correlation	-0.024	-0.102	--	
	Sig. (2-tailed)	0.702	0.100		
	N	261	261	261	
Strategies for technology adoption	Pearson Correlation	.337**	.347**	0.043	--
	Sig. (2-tailed)	0.000	0.000	0.486	
	N	261	261	261	261

As shown in Table 7.1 above, there was a strong positive correlation between the ways in which 4IR technologies are used and the benefits of 4IR technologies (0.663, $p < 0.01$). There was a negative correlation between the ways in which 4IR technologies are used and the barriers to adopting 4IR technologies, which was statistically insignificant (-0.024, $p < 0.05$).

Despite the barriers that manufacturing SMEs in KZN face with regard to the adoption of 4IR technologies, it can be inferred that they have a strategic desire to maximise the benefits of technological innovation by utilising a wider spectrum of 4IR technologies. To enable manufacturing SMEs to realise these benefits, it is imperative to develop a framework that guides technology adoption. The framework presented in Figure 7.1 below is designed to aid manufacturing SMEs in navigating the challenges presented by technology adoption, which include government regulations, managerial awareness, digital competence, technological advances, obtaining specialist support, and the complex dynamics of technological resistance. The framework also provides guidance in navigating environmental issues such as infrastructural challenges and competition. Applying this framework effectively will assist manufacturing SMEs in KZN to address obstacles, enhance informed decision making, and improve their competitiveness and sustainability.

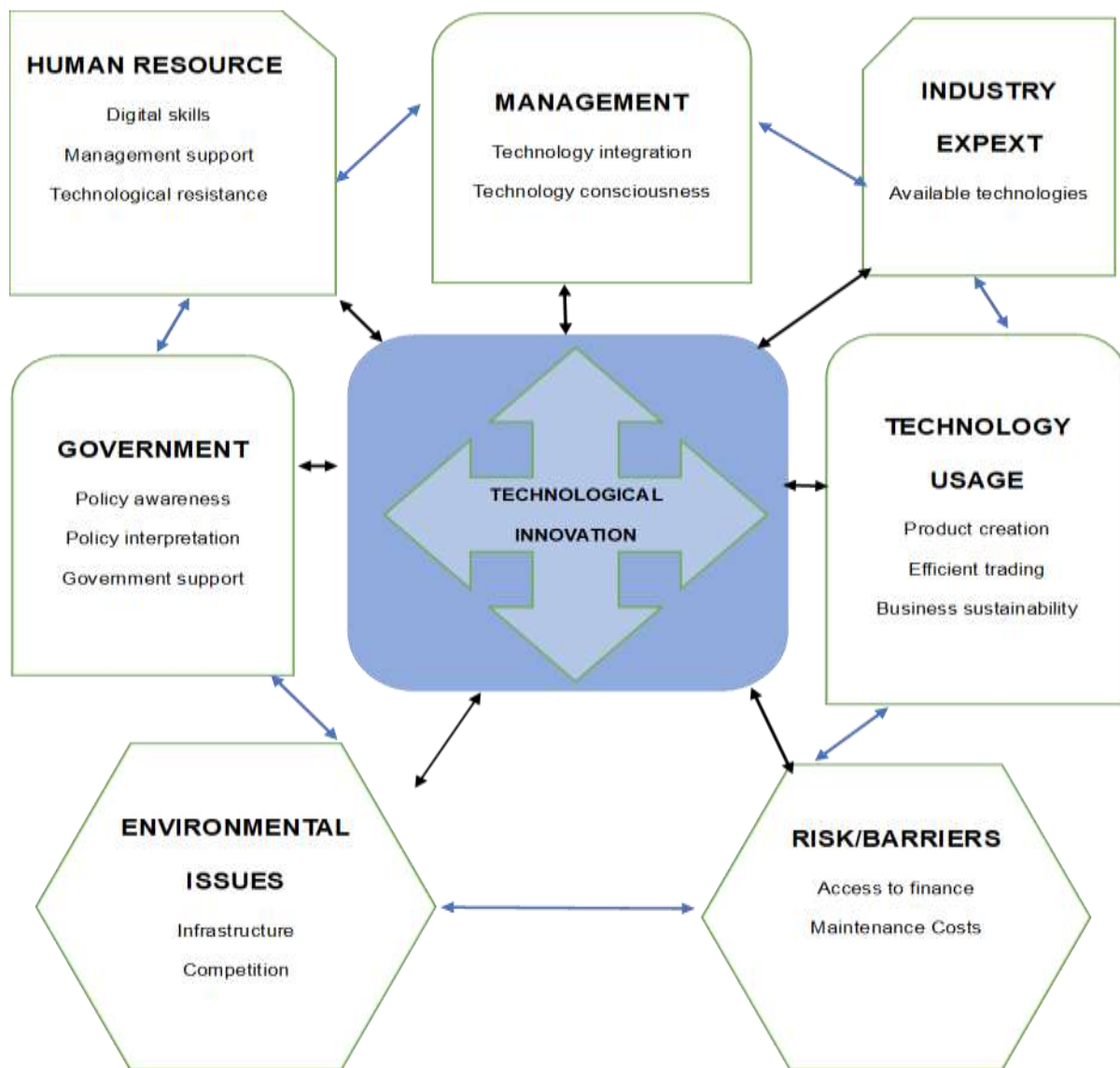


Figure 7.1: Proposed framework for supporting technological innovation

7.4.1 Human resources

The findings of this study indicate that manufacturing SMEs struggle to attract employees who possess the required digital competencies to effectively utilise technological innovations. This impedes the successful integration of technology into manufacturing processes and makes it difficult for SMEs to recognise and evaluate technological barriers and to navigate past them. These findings suggest that digital skills are essential for maximising the effectiveness and efficiency of technological innovations in the manufacturing industry, and that a lack of digital skills could result in inefficiencies, a decline in production, and a surge in operational flaws. In addition,

a lack of digital skills contributes to the reluctance of employees to adopt new technologies, as employees who lack digital skills are unable to exploit the advanced capabilities of new technologies. However, lessons can be learned from the notable proportion of the manufacturing SMEs in this study (43.3%) that have devised strategies to employ technologically knowledgeable employees. This result suggests that the managers of these SMEs have embraced a proactive stance and understand the importance of recruiting technologically knowledgeable employees. This could result in smoother integration of cutting-edge technologies and increased overall operational efficiency in these SMEs.

It is advised that manufacturing SMEs prioritise investing in comprehensive training initiatives aimed at improving the digital capabilities of its employees. Such training will enable employees to develop their proficiency in using technologies, as well as in troubleshooting them for optimal utilisation. Workshops, online courses, and establishing a culture that promotes ongoing education and flexibility in response to technological developments will also help overcome operational obstacles and boost overall productivity. These measures will ensure that employees are equipped to handle the complexity of contemporary technologies.

7.4.2 Management

The qualitative findings based on the interviews that were conducted with IT experts highlighted the role of management in technology adoption. Managers play a critical role in strategising innovation in production processes and the integration of technology. Managers should carefully consider the systematic integration of technology and determine the anticipated results and the expected time frame for achieving them. This requires a deliberate and strategic approach to the integration process. To successfully implement a technological innovation within a firm, managers must clearly understand the significance of the technology and how it will synchronise with the firm's manufacturing operations.

This study recommends that managers of manufacturing SMEs attend external workshops, seminars, and industry conferences focused on 4IR technologies. In addition to enabling managers to acquire innovative skills and knowledge, participating

in such programmes motivates them to think strategically regarding the use of technological innovations to eradicate deficiencies and enhance operations. Attending programmes that expose them to 4IR technologies and best practices will help managers develop a strategic mentality and provide them with the skills required to plan and implement innovative production processes in a methodical manner. Additionally, the networking possibilities provided by such programmes enable managers to establish relationships with colleagues in the sector and possible partners, which ultimately leads to strategic alliances and funding options that can expedite the process of integrating technology.

Cultivating an OC that embraces ongoing learning and adaptability to advancements in technology will enable managers to remain current with the most recent developments in the digital environment. Manufacturing SMEs should consider developing in-house learning resources such as knowledge repositories, online libraries, and e-learning platforms, and making these resources easily accessible to employees for self-study and reference.

7.4.3 Industry experts

Engagement with technology experts proved crucial in gaining a comprehensive understanding of technology adoption processes among manufacturing SMEs in KZN. These professionals assisted in establishing links between theoretical concepts and real-world applications and provided insightful advice for manufacturing SMEs considering technology integration. Discussions with these professionals highlighted that manufacturing SMEs that are resistant to adopting technology lack in-house expertise on the latest technologies. As a result, manufacturing SMEs that neglect to seek guidance from technology specialists continue to grapple with ineffective technology adoption procedures and run the risk of investing in technologies that fail to meet their unique requirements.

However, the quantitative results of this study indicate that 17.2% of manufacturing SMEs in KZN have devised a strategy to actively evaluate the benefits and risks of technology adoption. Participating in an IT risk-benefit evaluation process with the aid of IT experts is likely to result in easier and more fruitful transitions to new

technologies, as such experts can assist SMEs to efficiently navigate challenges, make strategic decisions that are in line with their business objectives, and deploy technologies that foster long-term success. In addition, manufacturing SMEs should proactively consult with technology experts for advice, as such consultations yield insightful information that enhances decision-making processes and reduces the likelihood of inefficient technology adoption processes.

This study's proposed framework for fostering technological innovation among KZN manufacturing SMEs includes both professional risk-benefit analysis and proactive consultation with technology experts. Insufficient attention to either of these aspects will have adverse impacts on the adoption of 4IR technologies, such as inefficiencies, lost opportunities and less than ideal results from technology integration initiatives.

7.4.4 Government policy

Manufacturing SMEs in KZN have faced challenges in understanding government policies and have been found to be unaware of support initiatives that are available. This lack of understanding and proficiency in interpreting policies has impeded the region's economic advancement. As a result, the region's employment rate and general economic growth have not improved considerably. On the other hand, a small proportion of manufacturing SMEs (16.4%) have acknowledged the existence of government aid programmes and have effectively utilised and profited from them. This suggests that proactive information-seeking efforts, efficient communication channels, and a greater degree of involvement with government bodies have contributed to the favourable experiences of these SMEs.

A review of South Africa's post-2000 industrial policy by Altman and Mayer (2003) identifies gaps in attaining key socioeconomic objectives such as overall GDP growth, job creation, and income redistribution. These gaps indicated that post-1994 policy objectives, which focused on enabling the manufacturing sector to bring benefits such as increased economic independence and worldwide competitiveness, had not been met. The consequences of these deficiencies have been apparent in the failure of KZN's economy to meet regional and national imperatives. The establishment of a framework to support manufacturing SMEs will contribute significantly towards

regional and national objectives such as economic growth, poverty reduction, and employment creation. This study's objective of analysing the benefits of technologies adopted by manufacturing SMEs in KZN is strongly related to the concerns mentioned in the above-mentioned post-2000 industrial policy review. The shortcomings identified in this review can be successfully addressed by a well-aligned framework that focuses on the issues of GDP growth, job creation, and income redistribution in line with the overarching policy objectives. The proposed framework has great potential to contribute to regional and national objectives by leveraging technology to increase the productivity and competitiveness of manufacturing SMEs. This aligns with both regional and national objectives that aim to address the above-mentioned issues and strive to build a more robust and diverse economy. A variety of strategies can be used to effectively implement the framework as a model and attain the desired objectives of greater employment, less poverty, and enhanced economic circumstances. Supportive policies such as tax breaks and regulatory easing should be developed to foster the growth of SMEs. To improve manufacturing SMEs' chances of obtaining government assistance for utilising innovative technologies, this study recommends simplifying the application procedure, delivering comprehensible information, broadening eligibility conditions, and minimising avoidable holdups. This is necessary in order to improve innovation and growth in the economy.

7.4.5 Technology usage

The inability of manufacturing SMEs to effectively utilise technologies for product creation has been attributed to various factors, including technology misalignment. While the majority of the manufacturing SMEs in this study indicated that they used technologies for marketing purposes, only a minority indicated that they use technologies for product creation. This indicates that the majority of these SMEs had not realised the benefits of enhanced product innovation. However, 34.7% of the manufacturing SMEs utilised technology to create new products, which increased their operational effectiveness and improved their capacity to respond quickly to changing market demands. The ability of manufacturing SMEs to adjust quickly to changing market demands, which is made possible by technology-driven product development, has a substantial influence on both globalisation and sustainability.

To foster a more thorough understanding of the potential benefits of technology-driven product development, manufacturing SMEs should implement educational initiatives aimed at their sector. This can be accomplished by presenting effective case studies in which the use of technology has boosted product innovation, market response, and overall firm success. Additionally, it is recommended that manufacturing SMEs hold training sessions and workshops to improve their employees' understanding of the effective alignment of technology with product innovation goals.

7.4.6 Barriers

The findings of this study indicated that high costs have been a significant hindrance to technology adoption by manufacturing SMEs. To be able to adopt technology, manufacturing SMEs require financial resources to obtain essential ICT equipment and software licences and to cover expenses associated with the implementation of technology. In addition, the deployment of technology involves continuous maintenance costs. Therefore, manufacturing SMEs require a solid financial base to cover initial investments and daily expenses and to effectively address any challenges that may arise during the implementation of new technologies. The implementation of new systems may result in unforeseen complexities and compatibility issues, which result in the additional costs of employing IT experts to resolve such issues.

This study recommends that funding in the form of loans or government grants be made available to increase the extent to which manufacturing SMEs are able to leverage technology. This will enable SMEs to easily obtain assistance with challenges encountered during the technology adoption process. By identifying financial strategies, additional financing sources, and unforeseen challenges, the framework proposed in this study enables manufacturing SMEs to be adequately prepared to navigate the financial challenges related to technology adoption and to manage their innovation projects successfully.

7.4.7 Environmental issues

To be able to adopt new technologies, manufacturing SMEs require access to digital infrastructure, a reliable electricity supply, and Internet connectivity. The empirical

findings of this study indicate that the majority of manufacturing SMEs in KZN face challenges with infrastructural availability that impede the adoption of 4IR technologies. While 5.8% of manufacturing SMEs in KZN had not experienced infrastructural challenges that prevented them from implementing 4IR technologies, the vast majority of SMEs had confronted infrastructure-related obstacles and were thus at a competitive disadvantage due to their technological deficiencies. Market share competition among manufacturing SMEs has the potential both to stimulate advancements and to present challenges. Therefore, manufacturing SMEs must be able to innovate, adapt, control expenses, and forge strong bonds in order to preserve or improve their competitive edge in the ever-changing business environment. In addition, the incapacity of manufacturing SMEs in KZN to implement 4IR technologies impedes the region's overall economic growth, as sectoral transformation typically requires higher productivity and innovation.

One proposed solution is to advocate for the government to create policies that promote technological advancement. This can be accomplished by engaging in consultation processes conducted by the government, such as workshops, open forums, and policy formation discussions. Partaking in such processes will enable manufacturing SMEs to contribute to policymaking by sharing their experiences and ideas. For manufacturing SMEs in KZN, embracing this framework is crucial as it serves a guide for overcoming infrastructural barriers to technology adoption. Through proactive engagement with policymakers and advocacy for supportive legislation, manufacturing SMEs will surmount infrastructural barriers and cultivate an environment that promotes innovation and sustainability. In addition, this framework will enable manufacturing SMEs to enhance their competitive advantage in the market and foster improved efficiency, innovative thinking, and regional economic development.

7.5 Limitations of the study

As this study focused on examining manufacturing enterprises in the province of KZN, the conclusions drawn from this study relied on the viewpoints of managers of manufacturing SMEs and IT experts within that province. Therefore, the findings of this study cannot be generalised to other types of SMEs or to SMEs in other provinces

in South Africa. However, given that many of the variables exhibit commonalities across different provinces, the findings can be utilised to improve the growth and sustainability of SMEs in South Africa.

7.6 Areas for further research

This study has identified several areas in which there is potential for further exploration.

Firstly, future studies should explore more thoroughly the characteristics and competencies that support the effective role of management in the adoption of technology. Examining how managerial approaches and organisational structures affect technology integration will yield insightful information that can be used to develop customised training curricula for manufacturing SMEs. In addition, examining the relationship between management awareness and the general efficacy of technology adoption projects would help develop a more enlightened understanding of the effect of managerial decisions on organisational results.

Secondly, future research should examine the ways in which financial incentives, supportive policies, and regulatory frameworks affect SMEs' technology investment decisions. This will aid managers of manufacturing SMEs and policymakers in understanding the factors that promote and obstruct the adoption of new technologies by SMEs. A better understanding of these factors will help in designing focused projects that motivate SMEs to adopt technology for the manufacturing of new products.

Lastly, subsequent studies should analyse the influence of consultation with technology specialists on the integration and efficacy of new technologies in manufacturing SMEs. This is crucial in order to identify trends, best practices, and success factors that will assist managers to make well-informed decisions and streamline the technology adoption process.

7.7 Conclusion

The significance of the sustainability of manufacturing SMEs in achieving both provincial and national economic goals cannot be overstated. Embracing technological innovations is an important means for SMEs to maintain competitiveness and improve manufacturing operations. Despite the substantial obstacles to the adoption of technological innovations by SMEs, the adoption of CC can considerably reduce their expenses. This study contributes to the existing body of knowledge by proposing a model intended to serve as a roadmap for policymakers, industry professionals, managers of manufacturing SMEs, and higher education institutions. This model aims to facilitate the seamless integration of technological innovation in manufacturing SMEs, thereby fostering sustainable economic growth in South Africa.

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APPENDIX A: QUESTIONNAIRE

SECTION A: GENERAL BACKGROUND INFORMATION

PLEASE MARK YOUR RESPONSE TO EACH QUESTION (FOR PAPER SURVEYS, MARK WITH AN X)

What type of manufacturing sector are you?

- Automotive
- Metal
- Textile and clothing
- Paper industry
- Chemical industry
- Pharmaceutical industry
- Furniture and fixtures
- Household goods
- Craft

Other.....

Are you the owner of this organisation?

- No
- Yes

What is your current position in the firm?

- Managing director
- Computer/IT manager
- Marketing manager
- Owner
- Other level (specify).....

What is your highest educational level?

- Primary
- Secondary/High school
- Certificate
- Diploma
- Bachelor degree/Advanced Diploma
- Master's degree

Other level (specify).....

Number of employees in the firm?

- 1-49 employees
- 50-99 employees
- 100-200 employees
- More than 200 employees

How long has your firm been operating?

- Less than 5 years
- 5 -10 years
- 11-15 years
- 16-20 years
- More than 20 years

Other (specify).....

Where is your firm located?

- Durban
- Pietermaritzburg
- Pine Town
- Newlands East
- Mount Edgecombe

Other (specify).....

PLEASE MARK YOUR RESPONSE TO EACH QUESTION (FOR PAPER SURVEYS, MARK WITH AN X)

The following segment is intended to collect data on the adoption of Fourth Industrial Revolution technology by manufacturing SMEs.

SECTION B: RANGE OF WAYS IN WHICH 4th INDUSTRIAL REVOLUTION TECHNOLOGIES ARE USED BY MANUFACTURING SMES IN KZN.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	ICT adopted is used for the creation of new products/services.					
2.	4IR technology is utilised to provide more timely and accurate information for decision making.					
3.	4IR technologies enables my firm to trade globally efficiently.					
4.	ICT enhances competitive advantage.					
5.	ICT is used to assist business activities such as research and development, distribution and sales and feedback.					
6.	The chosen technology allows for integration and connection of application. The ICT adopted expedites the day-to-day functions of the enterprise					
7.	The adopted technology supports business innovation and sustainability.					
	The adopted technology is a key driver in meeting customer needs and satisfaction.					
8.	ICT is used to facilitate the supply and access of a wide range of financial services, increasing efficiency and reducing costs.					
9.	The chosen 4IR innovation is used to enhance the efficiency of manufacturing SMEs through eliminating repetitive tasks.					

PLEASE MARK YOUR RESPONSE TO EACH QUESTION (FOR PAPER SURVEYS, MARK WITH AN X)

SECTION C: THE STRENGTHS/BENEFITS ASSOCIATED WITH THE ADOPTED 4IR TECHNOLOGIES IN THE ENHANCEMENT/SUCCESS OF MANUFACTURING SMES IN KZN.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	4IR technology enables manufacturing SME to respond to the pressure for manufacturing SMEs to remain competitive while ensuring they improve their economic potential					
2.	Technology provides greater efficiency and versatility for manufacturing SMEs.					
3.	4IR technology enables manufacturing SMEs to better streamline workflows through tracking time taken in the manufacturing process.					
4.	The adopted technology allows manufacturing SMEs to increase collaboration with different marketing channels.					
5.	When appropriately integrated, technology can improve your office relations by making it easier for employees and customers alike to converse					
6.	ICTs facilitate the selective automation of processes related to supporting the field sales force and integrating sales activity into the company's information structure.					
7.	Adopted technology enables SME to facilitate the gathering of valuable competitive knowledge and consumer-related information that simplifies marketing decision processes.					
8.	ICTs provides SMEs with extraordinary capability to target specific groups of individuals precisely and enable them to practice mass-customization and one-to-one marketing strategies.					

9.	ICTs enhance the company's ability to coordinate activities regionally, nationally, and globally, creating many new interrelationships among them.					
10.	Technology reduces business costs, improve productivity, and strengthen growth possibilities.					

PLEASE MARK YOUR RESPONSE TO EACH QUESTION (FOR PAPER SURVEYS, MARK WITH AN X)

SECTION D: THE LIMITATIONS PRESENTED BY THE ADOPTION OF 4IR TECHNOLOGY IN THE SUCCESS OF MANUFACTURING SMEs.

1.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2.	High costs associated with the adoption of technology negatively impacts on the success of manufacturing SMEs.					
3.	Maintenance of 4IR technology hinders the successful implementation of technology by manufacturing SMEs.					
4.	The vulnerability associated with 4IR on security issues influence the resistance of technology adoption					
5.	Lack of infrastructure to support technology adoption limits the successful implementation of technology.					
6.	The incompatibility and complexity of technology hinders the successful adoption of 4IR technology.					
7.	Lack of understanding of the strategic importance of 4IR technology limits SME success.					
8.	The awareness and limited access to government assistance programmes hinders the success of manufacturing SMEs.					
9.	The lack of education leads manufacturing SMEs'					

	unpreparedness for 4IR technology adoption.					
10.	Lack of awareness about government policies and regulations negatively impacts on manufacturing SMEs.					
11.	The lack of managerial knowledge and skills on 4IR technologies is an impediment that places significant hardship on manufacturing SME success					
12	The lack training leads to manufacturing SMEs' unpreparedness for 4IR which hinders the ability to reap the benefits that come with the adoption of technology.					
	The cost of keeping up with the latest technology limits the successful adoption of technology					

PLEASE MARK YOUR RESPONSE TO EACH QUESTION (FOR PAPER SURVEYS, MARK WITH AN X)

SECTION E: THE PRACTICAL STRATEGIES FOR OVERCOMING BARRIERS TO IMPLEMENTATION OF 4IR BY SMES IN KZN.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	Part of my strategy is to employ technological savvy employees to successfully leverage ICT					
2.	My organisation has designed internal policy/s to promote ICT adoption.					
3.	My organisation has strategies in place to improve/encourage collaborate with larger firms.					
4.	I have skills development strategy in place to ensure successful implementation of technology					
5.	My organisation has an integrated infrastructure plan to prepare itself for the digital economy.					
6.	There is a strategy to actively participate in the IT benefit/risk evaluation process to assess					

	whether the benefits of IT for their business outweigh its risks					
7.	I have a strategy to evaluate my organisations capability to reap benefits from IT adoption.					
8.	My organisation has a strategy to encourage shareholder cooperation to improve the compatibility of IT applications with other SMEs that are active in different industries.					
9.	I have designed strategies to regulate the secure online transaction activities to reduce or prevent the attacks of hackers, viruses, and spyware.					
10.	My organisation has a strategy to ensure that the level of ICT knowledge and skills is improved.					
11.	My organisation has an investment strategy in place for technology adoption.					

SECTION G: QUALITATIVE QUESTIONS

PLEASE ANSWER THE FOLLOWING QUESTIONS IN THE SPACE PROVIDED

1. What range of ways is 4IR used in your organisation?

2. Does this firm collaborate with larger firms? If 'yes', please briefly describe this collaboration.

3. Please provide a summary of the strengths and weaknesses, support systems and challenges which you have experienced in the implementation of ICT solutions as a small or medium sized manufacturing business in KZN. Please include anything further which you feel would be of interest in this regard.

4. What are the practical strategies for overcoming barriers to implementation of 4IR technology by SMEs in KZN?

Thank you for your participation and your time in completing this questionnaire. If you are willing to be interviewed concerning these issues, please indicate this and add your contact details. (Note that these will be kept strictly confidential)

APPENDIX B: INFORMATION LETTER FOR QUESTIONNAIRE

Appendix



LETTER OF INFORMATION

Title of the Research Study: A framework for supporting technological innovation by manufacturing Small and Medium Enterprise's in KwaZulu-Natal.

Principal Investigator/s/researcher: Luyanda Loraine Bingwa.

Supervisor/s: Dr J Skinner and Dr M Ngibe

Brief Introduction and Purpose of the Study: As you know, the SME sector plays a pivotal role in the South African economy, accounting for the majority of businesses, contributing towards job creation and providing 80% of South Africa's GDP (Omri and Euchi, 2019:1). Although SMEs have been recognised globally as major economic contributors, compared to larger firms, you will also be aware that they face severe challenges that threaten their survival (Bushe, 2019). Technological advancement has influenced how business is conducted, and staying competitive requires that SMEs rethink efficient and innovative ways of conducting business through the integration of technology.

This study aims to develop a framework which can provide practical guidance for the adoption of 4IR technologies by manufacturing SMEs in KZN

Outline of the Procedures: Questionnaires will be distributed to registered manufacturing SME managers across KwaZulu-Natal. If current COVID-19 restrictions are still in place, then the use of survey monkey or google forms will be used to collect data.

Risks or Discomforts to the Participant: There will be no risks or discomforts related to the study.

Explain to the participant the reasons he/she may be withdraw from the Study: Participants may withdraw at any given point should they feel uncomfortable to continue with the research and there will not be any adverse consequences to their actions.

Benefits: It is envisaged that the findings from this study will assist SMEs in the adoption and integration of 4IR technologies to enhance their competitiveness and increase the sustainability of manufacturing SMEs.

Remuneration: Kindly note that, participation in this study is free and will not result in any form of remuneration.

Costs of the Study: Participants will not be expected to cover any cost towards this study.

Confidentiality: Confidentiality of participants is guaranteed as the participants will not be requested to fill in their names or contact details.

Results: The thesis will be available in the DUT library and interested participants may request an electronic copy. Any new findings that may arise during the course of the study will be communicated with the participants

6 August 2020

through the use of communication channels such as emails, calls or a personal visit.

Research-related Injury: There will be no risk or injury associated with the study.

Storage of all electronic and hard copies including tape recordings: Data collected will be stored by the researcher in the Department of Information and Corporate Management store room for the next five years, thereafter, hard copies will be shredded and electronic data will be permanently erased.

Persons to contact in the Event of Any Problems or Queries: Persons to Contact in the Event of Any Problems or Queries:

For more information or query please contact

Supervisor: Dr J Skinner
Cell: 083 658 5951
Email: janes@dut.ac.za

And

Co-Supervisor: Dr N Ngibe
Tel: 031 373 5858
Cell: 078 635 3982
Email: musawenkosin1@dut.ac.za

Researcher: Bingwa Luyanda Loraine
Cell: 081 885 4808/067 407 1952
Email: 21125254@dut4life.ac.za

OR

The Institutional Research Ethics administrator on 031 373 2900. Complaints can be reported to the DVC: TIP, Prof F. Otieno on 031 373 2382 or dvctip@dut.ac.za.

6 August 2020



CONSENT

Full Title of the Study: A framework for supporting technological innovation by manufacturing Small and Medium Enterprise's in KwaZulu-Natal.

Names of Researcher/s: Luyanda Loraine Bingwa

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Luyanda Loraine Bingwa, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Please tick (✓) the box below to acknowledge that you were fully informed by the researcher about the purpose of this research study and that your participation is voluntary.

I, Luyanda Bingwa herewith confirm that the above participant has been fully informed about the nature, conduct and risk of the above study.

Luyanda Loraine Bingwa	2021-07-20	
Full Name of Researcher	Date	Signature
Full Name of Witness (If applicable)	Date	Signature
Full Name of Legal Guardian (If applicable)	Date	Signature

6 August 2020

APPENDIX C: INTERVIEW SCHEDULE



INTERVIEW SCHEDULE

Good Day,

I hope you are well and safe.

1. Thank you very much for agreeing to take part in this interview which, as I explained, is an important part of my doctoral study into the use of 'fourth industrial revolution' (4IR) technology as a way of improving manufacturing SME success rates. By the end of the project, I am hoping to develop a framework to guide SMEs on the adoption of emerging technologies. I am a registered student for Doctor of Philosophy in Business and Information Management, at the Durban University of Technology (DUT) and the formal title of my research study is: "A framework for supporting technological innovation by manufacturing Small and Medium Enterprise's in KwaZulu-Natal.". Your input will help me to understand the issues from your own experiences as a manager.

I want to reassure you that your answers will be entirely anonymous, and I will also send you the recording after the interview if you wish. You will then be able to change any response should you want to. Are you happy that I record the interview?

1. Please tell me a little about your business. What type of manufacturing are you in and how many employees do you have? How long has your company been in existence?
2. As you know, I am particularly interested in any advanced technology your company uses. Do you currently use what we are calling 'Fourth Industrial Revolution' or '4IR' innovation in your organisation – either cloud computing for your administration, or other high-tech solutions for your production processes, for instance?
If 'yes':
 - a. Please explain the range of 4IR technologies your firm currently uses and why you selected those particular technologies.
 - b. Would you say that the decision to use these innovations has impacted on your firm's performance/profitability? In what ways?
 - c. And are there any other implications of ICT adoption which you have experienced since introducing them, for instance their impact on your work force?
 - d. Are you aware of other 4IR innovations that are available for manufacturing SMEs?
 - e. Please provide a summary of the strengths and weaknesses which you experienced in the implementation of ICT in your firm.
 - f. From your point of view, what are the key factors that hinder or contribute to the successful adoption of ICT?
 - g. Are there any financial or non-monetary support (government/private) available to support your firm with the adoption of 4IR technology? What do you know about them? and have you experienced them? Please tell me about your experiences.
2. if 'no':

- a) Please explain your reasons for not using any advanced technology in your firm and also, briefly explain how you have managed to sustain your business without the use of ICT.
- b) From your point of view, what are the key factors that hinder the successful adoption of ICT?
- c) Are there any financial or non-monetary support (government/private) available to support your firm with the adoption of 4IR technology? Would you consider using them? Please explain your feelings about these agencies.

Thank you for your participation and your time to answer the above questions.

APPENDIX D: INFORMATION LETTER FOR INTERVIEW SCHEDULE

Appendix



LETTER OF INFORMATION

Title of the Research Study: A framework for supporting technological innovation by manufacturing Small and Medium Enterprise's in KwaZulu-Natal.

Principal Investigator/s/researcher: Luyanda Loraine Bingwa.

Supervisor/s: Dr J Skinner and Dr M Ngibe

Brief Introduction and Purpose of the Study: As you know, the SME sector plays a pivotal role in the South African economy, accounting for the majority of businesses, contributing towards job creation and providing 80% of South Africa's GDP (Omri and Euchi, 2019:1). Although SMEs have been recognised globally as major economic contributors, compared to large firms, you will also be aware that they face severe challenges that threaten their survival (Bushe, 2019). Technological advancement has influenced how business is conducted, and staying competitive requires that SMEs rethink efficient and innovative ways of conducting business through the integration of technology.

This study aims to develop a framework which can provide practical guidance for the adoption of 4IR technologies by manufacturing SMEs in KZN.

Outline of the Procedures: Individual interviews with participants who are IT experts who are in the commercial industry will be conducted and if current COVID-19 restrictions are in existence then the use of survey monkey or google forms will be used to collect data. Interviews will last for 15 to 30 minutes.

Risks or Discomforts to the Participant: There will be no risks or discomforts related to the study.

Explain to the participant the reasons he/she may be withdraw from the Study: Participants may withdraw at any given point should they feel uncomfortable to continue with the research and there will not be any adverse consequences to their actions.

Benefits: It is envisaged that the findings from this study will assist SMEs in the adoption and integration of 4IR technologies to enhance their competitiveness and increase the sustainability of manufacturing SMEs.

Remuneration: Kindly note that, participation in this study is free and will not result in any form of remuneration.

Costs of the Study: Participants will not be expected to cover any cost towards this study.

Confidentiality: Interviews will be recorded by the principal researcher for the purpose of allowing the interviewer the opportunity to review and replay the recordings to identify key information when writing up findings. Recordings of the interview will not be shared with anyone but will be available at request by participants. In case the interviewee feels unease about being recorded, then the recorder will not be used.

6 August 2020

Results: The thesis will be available in the DUT library and interested participants may request an electronic copy. Any new findings that may arise during the course of the study will be communicated with the participants through the use of communication channels such as emails, calls or a personal visit.

Research-related Injury: There will be no risk or injury associated with the study.

Storage of all electronic and hard copies including tape recordings: Data collected will be stored by the researcher in the Department of Information and Corporate Management store room for the next five years, thereafter, hard copies will be shredded and electronic data will be permanently erased.

Persons to contact in the Event of Any Problems or Queries: Persons to Contact in the Event of Any Problems or Queries:

For more information or query please contact

Supervisor: Dr J Skinner
Cell: 083 658 5951
Email: janer@dut.ac.za

And

Co-Supervisor: Dr N Ngibe
Tel: 031 373 5858
Cell: 078 635 3982
Email: musawenkosini@dut.ac.za

Researcher: Bingwa Luyanda Loraine
Cell: 081 885 4808/067 407 1952
Email: 21125254@dut4life.ac.za

OR

The Institutional Research Ethics administrator on 031 373 2900, Complaints can be reported to the DVC: TIP, Prof F. Otieno on 031 373 2382 or dvctip@dut.ac.za.

6 August 2020



CONSENT

Full Title of the Study: A framework for supporting technological innovation by manufacturing Small and Medium Enterprise's in KwaZulu-Natal.

Names of Researcher/s: Luyanda Loraine Bingwa

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Luyanda Loraine Bingwa, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Please tick (✓) the box below to acknowledge that you were fully informed by the researcher about the purpose of this research study and that your participation is voluntary.

I, Luyanda Bingwa herewith confirm that the above participant has been fully informed about the nature, conduct and risk of the above study.

Luyanda Loraine Bingwa

2021-03-14

L Bingwa

Full Name of Researcher

Date

Signature

Full Name of Witness (If applicable)

Date

Signature

Full Name of Legal Guardian (If applicable)

Date

Signature

6 August 2020

APPENDIX E: ETHICAL CLEARANCE LETTER



Faculty Research Office
Durban University of Technology
30 June 2021

Student Luyanda Bingwa
Student Number: 21125254
Degree: PhD: Business and Information Management
Email: 21125254@dut4life.ac.za
Supervisor: Dr Jane Skinner
Supervisor email: janes@dut.ac.za

Dear Ms Bingwa

ETHICAL APPROVAL: LEVEL 2

I am pleased to inform you that the Faculty Research Ethics Committee (FREC) following feedback from two reviewers, has granted preliminary permission for you to conduct your research, 'A framework for supporting technological innovation by manufacturing Small and Medium Enterprise's in KwaZulu Natal'

When ethics approval is granted: You are required to present the letter at your research site(s) for permission to gather data. Please also note that your research instruments must be accompanied by the letter of information and the letter of consent for each participant, as per your research proposal.

This ethics clearance is valid from the date of provisional approval on this letter for one year. A student must apply for recertification 3 months before the date of this expiry.

Recertification is required every year until after corrections are made, after examination, and the thesis is submitted to the Faculty Registrar. A summary of your key research findings must be submitted to the FRC on completion of your studies.

Kindest regards.

Yours sincerely


Dr Mogiveny Rajkoomar
FREC Chair
Faculty of Accounting and Informatics
Durban University of Technology
Ritson Campus
Durban, South Africa
4001

APPENDIX F: CHI-SQUARE TEST

	Chi-Square	df	Asymp. Sig.
What type of manufacturing sector are you?	41,031	9	< 0.001
Are you the owner of this organisation?	1,383	1	0,240
What is your current position in the firm?	204,996	4	< 0.001
What is your highest educational level?	127,667	5	< 0.001
Number of employees in the firm?	104,042	3	< 0.001
How long has your firm been operating?	84,383	4	< 0.001
Where is your firm located?	238,471	5	< 0.001
ICT adopted is used for the creation of new products/services.	301,241	4	< 0.001
4IR technology is utilised to provide more timely and accurate information for decision making	450,322	4	< 0.001
4IR technologies enables my firm to trade globally efficiently.	411,625	4	< 0.001
ICT enhances competitive advantage.	210,054	4	< 0.001
ICT is used to assist business activities such as research and development, distribution and sales and feedback	324,268	4	< 0.001
The chosen technology allows for integration and connection of application. The ICT adopted expedites the data	326,452	4	< 0.001
The adopted technology supports business innovation and sustainability.	356,069	4	< 0.001
The adopted technology is a key driver in meeting customer needs and satisfaction.	391,203	4	< 0.001
ICT is used to facilitate the supply and access of a wide range of financial services, increasing efficiency and	448,981	4	< 0.001
The chosen 4IR innovation is used to enhance the efficiency of manufacturing SMEs through eliminating repetitive	397,831	4	< 0.001
4IR technology enables manufacturing SME to respond to the pressure for manufacturing SMEs to remain competitive	496,184	4	< 0.001
Technology provides greater efficiency and versatility for manufacturing SMEs.	441,165	4	< 0.001
4IR technology enables manufacturing SMEs to better streamline workflows through tracking time taken in the	466,375	4	< 0.001
The adopted technology allows manufacturing SMEs to increase collaboration with different marketing channels	362,544	4	< 0.001
When appropriately integrated, technology can improve your office relations by making it easier for employees	273,042	4	< 0.001
ICTs facilitate the selective automation of processes related to supporting the field sales force and integrating	329,019	4	< 0.001
Adopted technology enables SME to facilitate the gathering of valuable competitive knowledge and consumer-	376,989	4	< 0.001
ICTs provides SMEs with extraordinary capability to target specific groups of individuals precisely and enable	403,617	4	< 0.001
ICTs enhance the company's ability to coordinate activities regionally, nationally, and globally, creating many r	344,46	4	< 0.001
Technology reduces business costs, improve productivity, and strengthen growth possibilities.	204,881	4	< 0.001
High costs associated with the adoption of technology negatively impacts on the success of manufacturing SMEs	260,054	4	< 0.001
Maintenance of 4IR technology hinders the successful implementation of technology by manufacturing SMEs	291,739	4	< 0.001
The vulnerability associated with 4IR on security issues influence the resistance of technology adoption	282,123	4	< 0.001
Lack of infrastructure to support technology adoption limits the successful implementation of technology.	335,188	4	< 0.001
The incompatibility and complexity of technology hinders the successful adoption of 4IR technology.	345,877	4	< 0.001
Lack of understanding of the strategic importance of 4IR technology limits SME success.	368,253	4	< 0.001
The awareness and limited access to government assistance programmes hinders the success of manufacturing	407,142	4	< 0.001
The lack of education leads manufacturing SMEs' unpreparedness for 4IR technology adoption.	253,272	4	< 0.001
Lack of awareness about government policies and regulations negatively impacts on manufacturing SMEs.	247,64	4	< 0.001
The lack of managerial knowledge and skills on 4IR technologies is an impediment that places significant h	244,383	4	< 0.001
The lack training leads to manufacturing SMEs' unpreparedness for 4IR which hinders the ability to reap the b	269,326	4	< 0.001
The cost of keeping up with the latest technology limits the successful adoption of technology	227,716	4	< 0.001
Part of my strategy is to employ technological savvy employees to successfully leverage ICT	126,261	4	< 0.001
My organisation has designed internal policy/s to promote ICT adoption.	359,862	4	< 0.001
My organisation has strategies in place to improve/encourage collaborate with larger firms.	386,874	4	< 0.001
I have skills development strategy in place to ensure successful implementation of technology	348,291	4	< 0.001
My organisation has an integrated infrastructure plan to prepare itself for the digital economy.	391,318	4	< 0.001
There is a strategy to actively participate in the IT benefit/risk evaluation process to assess whether the benefi	434,46	4	< 0.001
I have a strategy to evaluate my organisations capability to reap benefits from IT adoption.	427,64	4	< 0.001
My organisation has a strategy to encourage shareholder cooperation to improve the compatibility of IT applica	460,322	4	< 0.001
I have designed strategies to regulate the secure online transaction activities to reduce or prevent the attacks	509,939	4	< 0.001
My organisation has a strategy to ensure that the level of ICT knowledge and skills is improved.	422,391	4	< 0.001
My organisation has an investment strategy in place for technology adoption.	393,004	4	< 0.001
Does this firm collaborate with larger firms? If 'yes', please briefly describe this collaboration.	200,923	1	< 0.001

APPENDIX G: FACTOR ANALYSIS

Factor Analysis										
Notes										
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Comments										
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Cases Used LISTWISE: Statistics are based on cases with no missing values for any variable used.										
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KMO and Bartlett's Test										
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0,841									
Approx. Chi-Square	529,599									
Bartlett's Test of Sphericity	df 45									
Sig.	0,000									
Communalities										
	Initial	Extraction								
ICT adopted	1,000	0,398								
4IR technol	1,000	0,388								
4IR technol	1,000	0,543								
ICT enhanc	1,000	0,576								
ICT is used	1,000	0,343								
The chosen	1,000	0,458								
The adopter	1,000	0,457								
The adopter	1,000	0,451								
ICT is used	1,000	0,450								
The chosen	1,000	0,595								
Extraction Method: Principal Component Analysis.										
Total Variance Explained										
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings						Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	
1	3,522	35,223	35,223	3,522	35,223	35,223	2,530	25,299	25,299	
2	1,135	11,347	46,570	1,135	11,347	46,570	2,127	21,271	46,570	
3	0,954	9,535	56,106							
4	0,801	8,007	64,113							
5	0,713	7,126	71,238							
6	0,685	6,849	78,087							
7	0,644	6,438	84,525							
8	0,595	5,949	90,474							
9	0,551	5,514	95,988							
10	0,401	4,012	100,000							
Extraction Method: Principal Component Analysis.										
Component Matrix^a										
	Component									
	1	2								
ICT adopted	0,456	0,436								
4IR technol	0,580	0,226								
4IR technol	0,460	-0,575								
ICT enhanc	0,490	0,579								
ICT is used	0,579	0,087								
The chosen	0,672	-0,086								
The adopter	0,627	-0,251								
The adopter	0,641	0,201								
ICT is used	0,620	-0,255								
The chosen	0,742	-0,209								
Extraction Method: Principal Component Analysis.										
a. 2 components extracted.										

Section	Kaiser-Meyer-Olkin	Bartlett's Test of Sphericity		
		rox. Chi-Sq.	df	Sig.
B	0,841	529,599	45	< 0,001
C	0,730	601,160	45	< 0,001
D	0,805	983,058	66	< 0,001
E	0,843	843,434	55	< 0,001

Rotated Component Matrix ^a		
B	Component	
	1	2
ICT adopted	0,068	0,627
4IR technok	0,298	0,547
4IR technok	0,722	-0,143
ICT enhanc	0,001	0,759
ICT is used	0,386	0,440
The chosen	0,569	0,367
The adoptec	0,641	0,212
The adoptec	0,360	0,567
ICT is used	0,639	0,205
The chosen	0,702	0,319

Extraction Method: Principal Component Analysis.
a. Rotation converged in 3 iterations.

Component Transformation Matrix		
Component	1	2
1	0,764	0,645
2	-0,645	0,764

Extraction Method: Principal Component Analysis.

Factor Analysis

Notes

Output Created 22 13:14:21

Comments

Input

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Missing Value Definition of MISSING=EXCLUDE: User-defined missing values are treated as missing.
Cases Used: LISTWISE. Statistics are based on cases with no missing values for any variable used.

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KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy 0,730

Approx. Chi-Square 601,160

Bartlett's Test of Sphericity 45

Sig. 0,000

Communalities

	Initial	Extraction
4IR technok	1,000	0,606
Technology	1,000	0,677
4IR technok	1,000	0,472
The adoptec	1,000	0,610
When apprc	1,000	0,671
ICTs facilitat	1,000	0,500
Adopted tec	1,000	0,435
ICTs providk	1,000	0,575
ICTs enhanc	1,000	0,714
Technology	1,000	0,633

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,259	32,593	32,593	3,259	32,593	32,593	2,282	22,824	22,824
2	1,596	15,957	48,550	1,596	15,957	48,550	1,849	18,490	41,314
3	1,038	10,378	58,927	1,038	10,378	58,927	1,761	17,613	58,927
4	0,800	8,001	66,929						
5	0,716	7,161	74,090						
6	0,707	7,068	81,158						
7	0,630	6,304	87,462						
8	0,508	5,085	92,547						
9	0,425	4,250	96,796						
10	0,320	3,204	100,000						

Extraction Method: Principal Component Analysis.

Component Matrix ^a			
	Component		
	1	2	3
4IR technol	0,576	0,091	-0,516
Technology	0,512	0,237	-0,599
4IR technol	0,669	-0,039	-0,152
The adoptec	0,508	-0,575	0,149
When apprc	0,538	-0,595	0,167
ICTs facilit	0,703	-0,019	0,070
Adopted tec	0,595	-0,255	0,126
ICTs provid	0,700	0,223	0,187
ICTs enhan	0,452	0,497	0,512
Technology	0,357	0,695	0,151
Extraction Method: Principal Component Analysis			
a. 3 components extracted.			
Rotated Component Matrix ^a			
C	Component		
	1	2	3
4IR technol	0,172	0,077	0,755
Technology	0,006	0,102	0,816
4IR technol	0,428	0,225	0,489
The adoptec	0,777	-0,068	0,046
When apprc	0,816	-0,057	0,045
ICTs facilit	0,499	0,372	0,335
Adopted tec	0,607	0,185	0,179
ICTs provid	0,363	0,599	0,290
ICTs enhan	0,101	0,837	-0,053
Technology	-0,201	0,736	0,224
Extraction Method: Principal Component Analysis			
a. Rotation converged in 5 iterations.			
Component Transformation Matrix			
Component	1	2	3
1	0,663	0,495	0,561
2	-0,692	0,691	0,208
3	0,284	0,527	-0,801
Extraction Method: Principal Component Analysis			
Factor Analysis			
Notes			
Output Created	22 13:14:54		
Comments			
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Missing Val	Definition of MISSING=EXCLUDE: User-defined missing values are treated as missing.		
	Cases Usec LISTWISE: Statistics are based on cases with no missing values for any variable used.		
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KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Meas	0,805		
Approx. Chi-	983,058		
Bartlett's Te df	66		
	Sig.	0,000	
Communalities			
	Initial	Extraction	
High costs a	1,000	0,411	
Maintenanc	1,000	0,561	
The vulnera	1,000	0,620	
Lack of infra	1,000	0,626	
The incompe	1,000	0,537	
Lack of und	1,000	0,575	
The awaren	1,000	0,411	
The lack of c	1,000	0,481	
Lack of awa	1,000	0,505	
The lack of i	1,000	0,559	
The lack trai	1,000	0,496	
The cost of	1,000	0,307	
Extraction Method: Principal Component Analysis			

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,926	32,718	32,718	3,926	32,718	32,718	3,554	29,618	29,618
2	2,163	18,021	50,739	2,163	18,021	50,739	2,535	21,121	50,739
3	0,988	8,233	58,972						
4	0,909	7,579	66,551						
5	0,760	6,333	72,884						
6	0,691	5,759	78,643						
7	0,550	4,586	83,230						
8	0,531	4,422	87,651						
9	0,441	3,671	91,322						
10	0,382	3,186	94,508						
11	0,359	2,992	97,500						
12	0,300	2,500	100,000						

Extraction Method: Principal Component Analysis.

Component Matrix ^a		
	Component	
	1	2
High costs a	0,534	-0,355
Maintenanc	0,608	-0,437
The vulnera	0,741	-0,268
Lack of infra	0,715	-0,338
The incompe	0,715	-0,161
Lack of unde	0,750	-0,116
The awaren	0,634	0,097
The lack of e	0,508	0,472
Lack of awa	0,441	0,557
The lack of r	0,351	0,660
The lack trai	0,339	0,617
The cost of	0,214	0,510

Extraction Method: Principal Component Analysis.
a. 2 components extracted.

Rotated Component Matrix ^a		
D	Component	
	1	2
High costs a	0,637	-0,070
Maintenanc	0,741	-0,109
The vulnera	0,781	0,102
Lack of infra	0,791	0,028
The incompe	0,709	0,186
Lack of unde	0,719	0,241
The awaren	0,518	0,377
The lack of e	0,234	0,653
Lack of awa	0,136	0,698
The lack of r	0,008	0,748
The lack trai	0,018	0,704
The cost of	-0,044	0,552

Extraction Method: Principal Component Analysis.
a. Rotation converged in 3 iterations.

Component Transformation Matrix		
Component	1	2
1	0,888	0,459
2	-0,459	0,888

Extraction Method: Principal Component Analysis.

Notes									
Output Created	22 13:15:16								
Comments									
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N of Rows in	261								
Missing Value	Definition of MISSING=EXCLUDE: User-defined missing values are treated as missing. Cases Use LISTWISE: Statistics are based on cases with no missing values for any variable used.								
Syntax	FACTOR /VARIABLES E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 /MISSING LISTWISE /ANALYSIS E1 E2 E3 E4 E5 E6 E7 E8								
Resources	Processor T00:00:00.02 Elapsed Time 00:00:00.02 Maximum Memory 16224 (15.844K) bytes								
KMO and Bartlett's Test									
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0,843								
Approx. Chi-Square	843,434								
Bartlett's Test of Sphericity	55								
Sig.	0,000								
Communalities									
	Initial	Extraction							
Part of my s	1,000	0,571							
My organisa	1,000	0,501							
My organisa	1,000	0,667							
I have skills	1,000	0,596							
My organisa	1,000	0,621							
There is a s	1,000	0,671							
I have a stra	1,000	0,566							
My organisa	1,000	0,612							
I have desig	1,000	0,585							
My organisa	1,000	0,748							
My organisa	1,000	0,489							
Extraction Method: Principal Component Analysis									
Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,184	38,038	38,038	4,184	38,038	38,038	2,478	22,530	22,530
2	1,418	12,890	50,928	1,418	12,890	50,928	2,239	20,357	42,887
3	1,023	9,303	60,231	1,023	9,303	60,231	1,908	17,344	60,231
4	0,779	7,084	67,316						
5	0,696	6,325	73,641						
6	0,628	5,712	79,353						
7	0,563	5,120	84,473						
8	0,528	4,803	89,276						
9	0,439	3,994	93,270						
10	0,398	3,617	96,887						
11	0,342	3,113	100,000						
Extraction Method: Principal Component Analysis.									
Component Matrix^a									
	Component								
	1	2	3						
Part of my s	0,362	0,616	0,245						
My organisa	0,623	0,215	-0,259						
My organisa	0,438	0,680	-0,110						
I have skills	0,629	0,437	0,098						
My organisa	0,668	-0,020	-0,417						
There is a s	0,687	-0,226	-0,384						
I have a stra	0,703	-0,250	0,098						
My organisa	0,691	-0,286	0,229						
I have desig	0,702	-0,248	-0,172						
My organisa	0,570	-0,081	0,645						
My organisa	0,607	-0,276	0,212						
Extraction Method: Principal Component Analysis									
a. 3 components extracted.									

Rotated Component Matrix ^a			
E	Component		
	1	2	3
Part of my s	-0,064	0,154	0,737
My organisa	0,555	0,113	0,424
My organisa	0,224	-0,072	0,782
I have skills	0,259	0,282	0,670
My organisa	0,749	0,121	0,212
There is a s	0,784	0,235	0,040
I have a stra	0,460	0,589	0,086
My organisa	0,367	0,688	0,065
I have desig	0,650	0,400	0,053
My organisa	-0,053	0,826	0,250
My organisa	0,320	0,621	0,036
Extraction Method: Principal Component Analysis			
a. Rotation converged in 6 iterations.			
Component Transformation Matrix			
Component	1	2	3
1	0,674	0,605	0,423
2	-0,219	-0,383	0,897
3	-0,705	0,698	0,126
Extraction Method: Principal Component Analysis			

APPENDIX H: TURNITIN REPORT

A framework for supporting technological innovation by manufacturing Small and Medium Enterprise's in KZN.

by Musawenkosi Ngibe

Submission date: 07-Apr-2024 12:49PM (UTC+0200)

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APPENDIX I: PROFESSIONAL EDITOR LETTER



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8 April 2024

DECLARATION OF PROFESSIONAL EDITING

This is to certify that the thesis written by **Luyanda Loraine Bingwa** and entitled:

**A FRAMEWORK FOR SUPPORTING TECHNOLOGICAL INNOVATION BY
MANUFACTURING SMALL AND MEDIUM ENTERPRISES IN KZN**

was copy edited for:

- Layout
- Pagination
- Formatting and numbering of headings, tables and figures
- Spelling, punctuation and grammar
- Language usage, style and consistency

A reconciliation of citations and the accompanying reference list was undertaken.

The author of the thesis was provided with suggested corrections/amendments which required action.

The author is responsible for implementing the suggested corrections/amendments in the final copy submitted for examination purposes.



John Goodier

Copy Editor